ROYAL BOTANIC GARDENS VICTORIA

Muelleria

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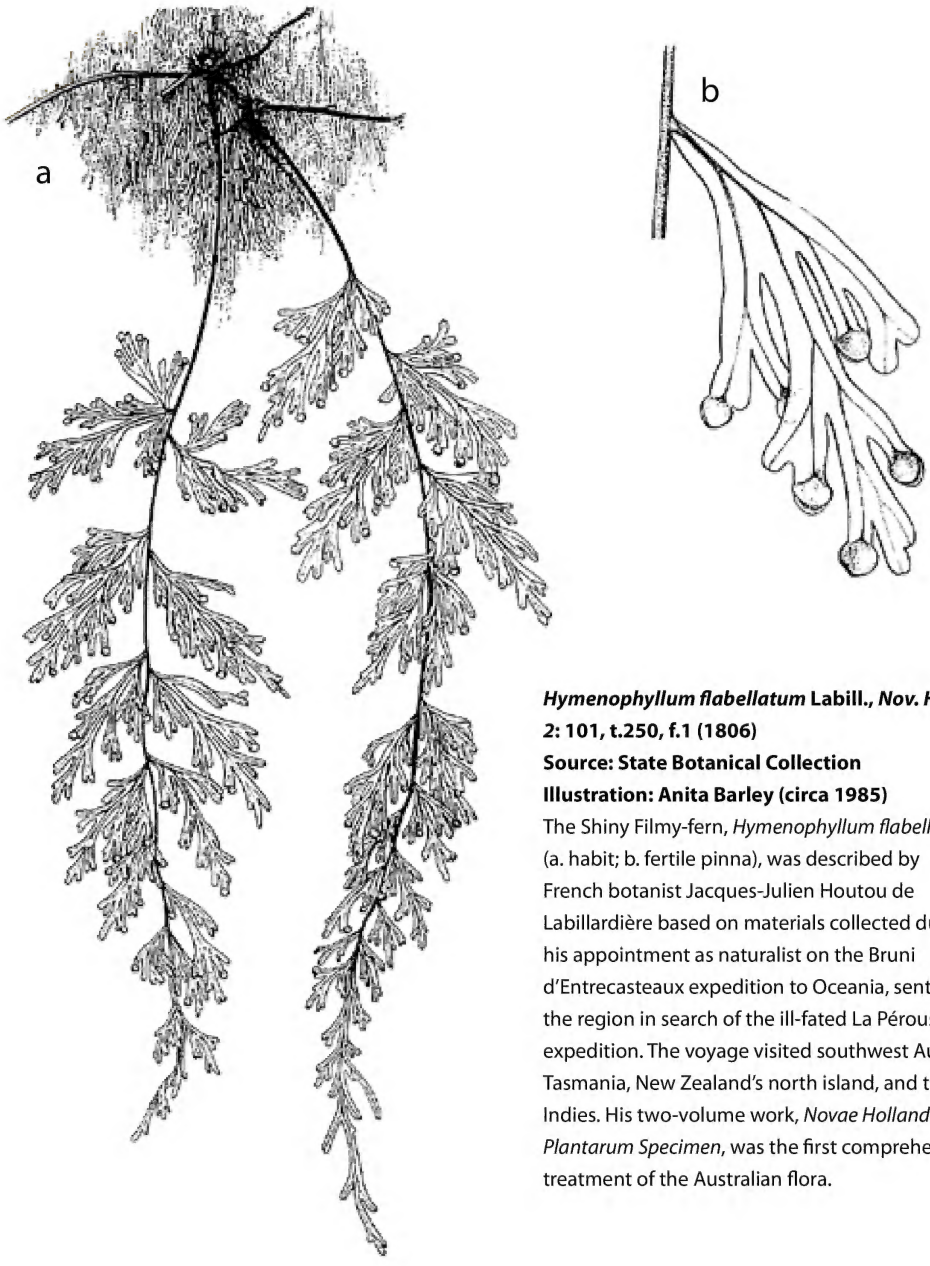

***Hymenophyllum flabellatum* Labill., *Nov. Holl. Pl. 2*: 101, t.250, f.1 (1806)**
Source: State Botanical Collection
Illustration: Anita Barley (circa 1985)
The Shiny Filmy-fern, *Hymenophyllum flabellatum* (a. habit; b. fertile pinna), was described by French botanist Jacques-Julien Houtou de Labillardière based on materials collected during his appointment as naturalist on the Bruni d'Entrecasteaux expedition to Oceania, sent to the region in search of the ill-fated La Pérouse expedition. The voyage visited southwest Australia, Tasmania, New Zealand's north island, and the East Indies. His two-volume work, *Novae Hollandiae Plantarum Specimen*, was the first comprehensive treatment of the Australian flora.

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ROYAL BOTANIC GARDENS VICTORIA

Acacia ureniae (Fabaceae: Caesalpinioideae), a new, rare wattle from eastern Victoria

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Introduction

A visit in January 2019 to privately owned bushland in the Cobungra (eastern Victoria) district allowed for a botanical survey in an area that has, to date, received little attention. Although the higher altitude parts of Cobungra, traversed by the Great Alpine Road, are readily accessible in many places, the Cobungra River has few points of easy approach. The visited property, 'Sinza', comprises ca. 40 ha of mature, subalpine woodland, mostly of northerly and north-westerly aspect, ranging from about 930 to 1000 m a.s.l. Numerous species of interest, including several listed as threatened under the Victorian Government Flora and Fauna Guarantee Act 1988, and others while not formally listed, acknowledged as vulnerable or endangered in the state (DEPI 2014) occur on the property. A surprising find was an *Acacia*, vegetatively superficially resembling some forms of *Acacia longifolia* (Andrews) Willd. or *A. melanoxylon* R.Br., but clearly neither of those species. The plants were in early bud. A subsequent visit to the property in October 2019 allowed collection of flowering specimens and an assessment of its local abundance.

Searches in the National Herbarium of Victoria, Royal Botanic Gardens Victoria (MEL), showed it to be distinct from any named species. A further two collections of the same entity, from sites within ca. 15 km of the Cobungra occurrence, were found at MEL, having previously been

Abstract

Acacia ureniae, a new species of the '*Acacia longifolia* group' from the Cobungra area in eastern Victoria is described, illustrated and mapped, and its habitat, distinctions from inferred related species and rarity are discussed. Its distinguishing characteristics include distinctive phyllode venation with the vein reticulum forming more-or-less isodiametric areoles and a lack of an obvious gland on the phyllode margin.

Keywords: Taxonomy, isodiametric reticulum, extra floral nectary, new species

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determined as potential hybrids between *Acacia alpina* F.Muell. and *A. dallachiana* F.Muell., and *A. dallachiana* and *A. phlebophylla* F.Muell. ex H.B.Will. respectively. None of these potential 'parent' species is known to occur in near proximity to 'Sinza', and the nearest area where at least two of these species occur in the same general area is at Mt Buffalo (where all three are found in close proximity). The taxon in question shared some obvious characters with these three species, including relatively stiff phyllodes that are conspicuously reticulate-veined, and spicate inflorescences, but several other features of the Cobungra plants are not possessed by any of these three species. The Cobungra wattle is here described as a new species.

Taxonomy

Acacia ureniae N.G.Walsh sp. nov.

Type: **AUSTRALIA.** Victoria, beside the Cobungra River, 4.7 km due N from Cobungra Rd/Great Alpine Rd junction, 8.x.2019, *N.G.Walsh 8970, E.A.James, J.Milne, L.J.Vaughan, P.Symes, A.U'Ren* (holo: MEL 2470075; iso: CANB, K, NSW *distribuendi*)

Erect *shrub* or small *tree* to ca. 5 m high, mostly single-stemmed from base but often branched from shortly above the ground; *bark* with conspicuous lenticels arranged in discontinuous horizontal lines; *branchlets* slightly angular with 3 low ridges excurrent from the base of each pulvinus, glabrous or occasionally with scattered, subappressed fine pale hairs to ca. 0.5 mm long on new growth. *Pulvinus* 2.5–3.5 mm long. *Phyllodes* rather stiffly erect, narrowly elliptic to narrowly obovate, 55–95 mm long, 7–16 mm wide (length-width ratio ca. 5–6.5), mid-green, dull, glabrous, apex obtuse, midvein and usually 2 longitudinal nerves prominent but not or hardly raised, often with 2–4 less distinct, approximately longitudinal nerves branching off from near the base of the more prominent nerves; reticulation obvious between longitudinal nerves with almost isodiametric areoles ca. 0.5–1 mm long and wide; gland absent. *Inflorescences* simple, spicate, 10–25 mm long at anthesis, 2 (or one by abortion) per axil, sessile; *rachis* very sparsely puberulous; *basal bract* solitary, broadly ovate to oblate, pouched, 2.5–3 mm long, brown, glabrous except for densely but minutely fimbriate margin, caducous; *bracts* subtending individual flowers obovate, ca. 1 mm diam., brown, densely and minutely fimbriate on margin, ±peltately attached to rachis by a thick densely pubescent column; *flowers* crowded on spike, obscuring the rachis, 4-merous, ca. 30–60 per spike, *sepals* broadly elliptic, ca. 1.2 mm long, fimbriate, sometimes with a few short hairs near base, united in the basal half; *petals* broadly ovate, ca. 1.5 mm long, glabrous; *stamens* ca. 3 mm long; ovaries normally 1 per flower (but see note below), minutely densely pubescent or sometimes glabrous, *styles* exceeding stamens by ca. 1 mm at anthesis. *Pods* cylindrical to submoniliform, slightly curved, 70–120 mm long, 3–4.5 mm wide, coriaceous but not much thickened, glabrous, to 12-seeded. *Seeds* longitudinal, flattened-ellipsoid, 4–5 mm long, 2.5–3 mm wide, dull, dark brown; *aril* white, ca. 2.5 mm long, compactly complicate with 2 or 3 bends. (Figs 1, 2a)

Specimens examined: Cobungra River, below Mt Higginbotham at junction with Murphys Creek, 13.i.1991, *R.Thomas 306* (MEL 2011776!); Kings Spur Track, 5.i.1991, *E.A.Chesterfield 3029* (MEL 2013215!, NY); Type locality, 17.i.2019, *N.G.Walsh 8907* (CANB!, MEL!); Type locality, 8.x.2019, *N.G.Walsh 8970a, E.A.James, J.Milne, L.J.Vaughan, P.Symes, A.U'Ren* (MEL!, CANB!, NSW!); South bank of the Cobungra River, 4.6 km NNW from Cobungra Rd/Great Alpine Rd junction, 8.x.2019, *N.G.Walsh 8977, E.A.James, J.Milne, L.Vaughan, P.Symes* (MEL!).

Distribution and habitat: Known from the vicinity of the Cobungra River from near its headwater below Mt Higginbotham to Cobungra settlement, and an isolated occurrence in the Dargo River catchment (the next major catchment to the south), ca. 12 km south of the nearest known occurrence.

Along the Cobungra River, *Acacia ureniae* occurs in riparian scrub and subalpine low forest, within ca. 10 m of the normal river level. At the Murphys Creek junction site, near the river's headwaters (MEL 2011776), the habitat is described as a 'cold air drainage zone', with associated species including *Eucalyptus stellulata* Sieber ex DC., *E. perriniana* F.Muell. ex Rodway and *E. dalrympleana* Maiden. At the type locality and nearby occurrences, it occurs in mostly rocky areas (schist and granite) with associated species including *E. pauciflora* Sieber ex Spreng. subsp. *pauciflora*, *Callistemon pityoides* F.Muell., *Grevillea lanigera* A.Cunn. ex R.Br., *Pomaderris phylicifolia* Lodd. ex Link subsp. *ericoides* (Maiden & Betche) N.G.Walsh & Coates, *Correa lawrenceana* Hook. var. *latrobeana* (F.Muell. ex Hannaford) Paul G.Wilson,

Figure 1. *Acacia ureniae*. **a:** flowering branch (from type plant *in situ*); **b:** seed (from *R.Thomas 306* (MEL), scale bar 1 mm); **c:** bark near base of trunk (from type observed plant *in situ*, ca 20 cm diam.).

Prostanthera phylicoides F.Muell. and *Acacia siculiformis* A.Cunn. ex Benth. The habitat at the Kings Spur site (MEL 2013215) is described as 'open *Eucalyptus pauciflora* woodland'. There is no indication of proximity to a watercourse at this site, and the occurrence is noted as an 'isolated specimen'.

Conservation Status: Owing to the difficulty of access to much of the Cobungra River, survey effort through the known range of *Acacia ureniae* is not high, so its conservation status is speculative at best. Near the type locality plants are uncommon—fewer than 100 plants in total were observed, on both sides of the river, along a ca. 1 km stretch searched in October 2019. More than 20 km separate the known occurrences along the Cobungra River, and a further ca. 10 km of potentially suitable habitat exists downstream to where the river enters highly modified farmland. At the type locality, shrubs of selected species, but primarily *Correa lawrenceana*, have been very heavily browsed by Sambar deer (*Rusa unicolor*). To date, no significant damage to plants of *A. ureniae* has been observed, but it is not known to what extent modification of the environment by Sambar may have on its recruitment and survival in the longer term. The known extent of occurrence (*sensu* IUCN 2012) is about 90 sq. km. Ignoring threats, if the number of locations is assumed to be fewer than five, an IUCN threat category of E, endangered, is supported (IUCN 2012). Further searches in the Cobungra and upper Dargo River catchments are required to allow a confident estimation of the species' threat status.

Etymology: The epithet honours Anne U'Ren whose commitment to conservation has ensured that the property supporting the type population of *Acacia ureniae* is preserved into the future. Anne and her husband Jim, have a deep appreciation of the many botanical values of their property and have had a permanent, legally binding conservation covenant applied to its title.

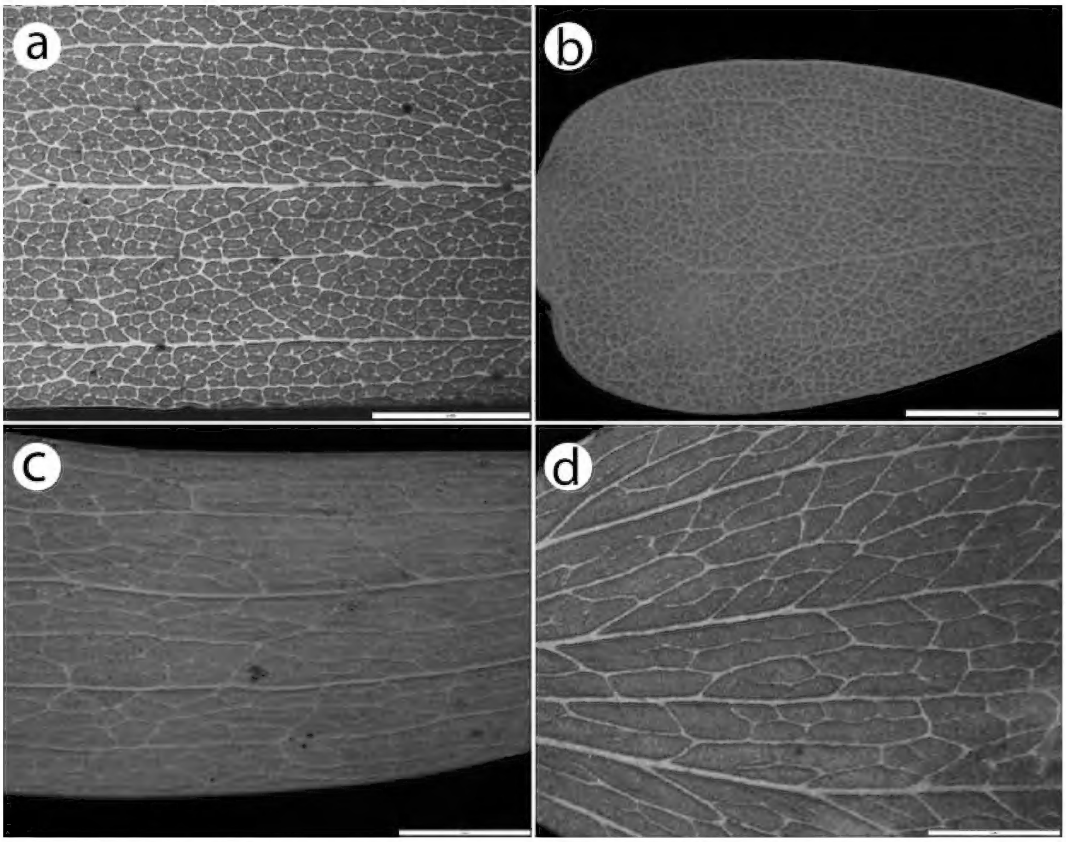

Figure 2. Phyllode reticulum. **a:** *A. ureniae* (from the type); **b:** *A. alpina* (MEL 287714); **c:** *A. dallachiana* (MEL 2063319); **d:** *A. phlebophylla* (MEL 2352868). Scale bars all 5 mm.

Notes: The new species appears most closely related to *Acacia dallachiana* and *A. phlebophylla* in having spicate inflorescences and prominently reticulate secondary venation of the phyllodes. It differs significantly from both of those species in having the reticulum composed of more-or-less isodiametric areoles, whereas both *A. dallachiana* and *A. phlebophylla* have areoles mostly more than three times longer than wide (Figure 2a, c, d). In those species the nerves that form the boundaries of the areoles are distinctly raised when dry, whereas those of *A. ureniae* are not or only very slightly raised on drying. The apparent lack of a nectary (gland) on the phyllodes and more compact inflorescences are other characters that further distinguish the new species from *A. dallachiana* and *A. phlebophylla*. From *A. dallachiana*, a rare species of north-eastern Victoria and adjacent areas in New South Wales, it further differs in the very compact, upright habit and shorter non-falcate phyllodes (phyllodes of *A. dallachiana* are typically distinctly falcate, 11-20 cm long) and non-pruinose growth tips. From *A. phlebophylla*, which is known only from Mt Buffalo, Victoria (ca. 45 km north-east of the nearest known occurrence of *A. ureniae*), it differs in the much narrower phyllodes (15–60 mm wide in *A. phlebophylla*) and much denser flower spikes (the rachides of the flower spikes of *A. phlebophylla* are clearly evident between individual flowers at anthesis).

Other, superficially similar members of the "Acacia longifolia group" (Brown *et al. 2010*) – a monophyletic plurinerved, spicate-inflorescence group of *Acacia* species from south-eastern Australia (e.g. *A. floribunda* (Vent.) Willd., *A. longifolia*, *A. maidenii* F.Muell., *A. mucronata* Willd. ex H.L.Wendl., *A. obtusifolia* A.Cunn.) either lack a distinct phyllode reticulum, or as in *A. dallachiana* and *A. phlebophylla*, the reticulum comprises elongate areoles. Furthermore,

each of these species, other than *A. floribunda* and sometimes *A. mucronata*, have distinct glands on the phyllode margins. *Acacia alpina*, another member of this group, does share with *A. ureniae* more or less isodiametric areoles (Figure 2b), but it is a low, often nearly prostrate shrub (rarely to ca 1.5 m high) of more elevated sites (above 1300 m), and has generally shorter (to 50 mm long), relatively broader phyllodes (length-width ratio typically about 2) that are usually glaucous to some extent. The marginal gland on the phyllode is often indistinct, but generally present and terminates a moderately prominent near-basal nerve. Presumed hybrids of *A. alpina* with *A. dallachiana* and *A. phlebophylla* have been collected from Mt Buffalo (MEL 2296005!, MEL 2071016! respectively). They bear a superficial resemblance to *A. ureniae* and the phyllode venation pattern renders more or less isodiametric areoles. However, they differ in the phyllodes being distinctly obovate with raised secondary venation and evident marginal glands, and the flower spikes with fewer, less crowded flowers. A note on MEL 2071016 states '*A. alpina* adjacent to hybrid plants, *A. phlebophylla* within ca. 20 m. Hybrids apparently sterile – both putative parent spp. with pods at time of collection'. The general geographic proximity of *A. alpina*, *A. dallachiana*, *A. phlebophylla* and *A. ureniae* does, however, suggest an ancient centre of origin in the vicinity and/or perhaps a hybridogenous origin of one or more of these species. The uniformity of plants at the Cobungra locality, and the absence of any of *A. alpina*, *A. dallachiana* and *A. phlebophylla* nearby indicates that, if of hybrid ancestry, *A. ureniae* is now a stable species. DNA analysis could help to determine if hybridisation has contributed to its evolution.

Acacia ureniae is very unusual in occasionally producing polygynous flowers (e.g. *N.G.Walsh 8970a et al.*). Up to six ovaries per flower have been observed, but, based on observations to date, normally the flowers have single ovaries, the normal state for *Acacia* (and indeed Fabaceae). Polygynoecy is known in the Western Australian species *A. celastrifolia* Benth., where flowers typically have three to five ovaries (Maslin 2001), but in that species it appears to be the normal condition. It is not closely related to *A. ureniae*, and is a segregate of the widespread, mostly southern Australian species, *A. myrtifolia* (Sm.) Willd.

Acknowledgements

I am very grateful to Anne U'Ren who introduced me to the new species and whose enthusiasm has encouraged its description. I am grateful too to my wife, Jan Walsh and colleagues Liz James, Pina Milne, Peter Symes and Luke Vaughan for assistance in the field, to Peter and Pina for photographs of *A. ureniae*, to Teresa Lebel and Andre Messina for assistance with figure preparation, and to Bruce Maslin and Dan Murphy for valuable discussions about *Acacia* taxonomy.

Postscript

'Sinza' was revisited in February 2020, following the catastrophic bushfires of summer 2019/2020. Of an estimated 80 plants of *A. ureniae* seen in the 2019 survey of the property, only four were found alive. It is not yet known if the populations on the upper Cobungra River and along Kings Spur (represented by MEL collections *R.Thomas 306* and *E.A.Chesterfield 3029* respectively) were burnt in the same fires, but they are close to, if not within the fire boundary. It is presumed that a new cohort will grow from soil-stored seed – the larger plants that were at Sinza were cohorts from the alpine fires of 2002/2003 – but to some extent, this will depend on favourable conditions for seedling development, rendering the suggested conservation status of Endangered as, at least in the short term, possibly conservative. Further searches are required and conservation seed collections strongly recommended.

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ROYAL BOTANIC GARDENS VICTORIA

A new fern record for Victoria, *Hymenophyllum marginatum* (Hymenophyllaceae)

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Introduction

Indigenous vascular plant species previously known only from states other than Victoria have been steadily added to the Victorian flora as new records, with 12 species added in the past decade (Table 1) and 13 species in the decade before that (Ross 2000; Ross & Walsh 2003; Walsh & Stajsic 2007; VicFlora 2020). In the last decade, most new records have been found towards the peripheries of the state, including in the far northwest (e.g. Moxham *et al.* 2019), far southwest, far northeast, and East Gippsland (Table 1). The most recent new Victorian plant record, discussed here, is a fern in the family Hymenophyllaceae, *Hymenophyllum marginatum* Hook. & Grev. (Figure 1). Prior to this discovery, the most recent new fern record for Victoria was *Cyclosorus interruptus* (Willd.) H.Ito (Thelypteridaceae), which was found near Portland in the far southwest of the state in 2008 (Sinclair *et al.* 2012).

Hymenophyllum marginatum was found on the Sealers Cove Walking Track, Wilsons Promontory National Park, in December 2019. There, it forms a dense, mat-like colony on a single, shaded, granite rock in wet sclerophyll forest with a canopy of *Eucalyptus viminalis* Labill. and typical wet forest understorey species such as *Cyathea australis* (R.Br.) Domin, *Lepidosperma elatius* Labill., *Olearia argophylla* (Labill.) Benth., and

Abstract

The fern *Hymenophyllum marginatum* Hook. & Grev. (Hymenophyllaceae) was recently discovered in Wilsons Promontory National Park, Victoria, representing a new record for a native vascular plant in Victoria previously known only from other states of Australia. The Victorian plants closely match populations found interstate in terms of both morphology and chloroplast *rbcL* sequences. A description of the species, its habitat and distribution are provided. The species' conservation status in Victoria and across its entire range is discussed.

Keywords: Taxonomy, filmy ferns

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Pomaderris aspera Sieber ex DC. (Figure 1A, 1B). Searches along the entire length of the track in similar habitat failed to locate any additional colonies. The Sealers Cove Walking Track is rich in other Hymenophyllaceae, including *Trichomanes caudatum Brack.*, *Hymenophyllum australe* Willd., *H. cupressiforme* Labill., *H. flabellatum* Labill., *H. rarum* R.Br. and *Trichomanes venosum R.Br.*, which comprise all of the Victorian representatives of the family except for *H. peltatum* (Poir.) Desv. *Hymenophyllum marginatum* has also been recorded in Queensland, New South Wales and Tasmania (Bostock & Spokes 1998).

Hymenophyllum marginatum is easily distinguished from other Hymenophyllaceae in Australia by its fronds, which have black margins. The fronds are usually simple or forked (Figure 1C, 1D), typically only once but rarely up to three times (Wilson 1990; Bostock & Spokes 1998). Simple or forked fronds with black margins are features shared with the New Zealand species, *H. armstrongii* (Baker) Kirk. *Hymenophyllum armstrongii* is also resolved as the closest relative of *H. marginatum* in phylogenies based on the chloroplast DNA regions *rbcL*, *rbcL-accD* and *rps4-trnS* (Hennequin *et al.* 2006). These two species form the subgenus *Craspedophyllum* C.Presl; however, recognising subgenus *Craspedophyllum* renders other subgeneric taxa polyphyletic and its retention has not been supported (Hennequin *et al.* 2006). *Hymenophyllum armstrongii* can be distinguished from *H. marginatum* by its toothed margins and glabrous midribs. The margins of *H. marginatum* are entire and the midribs, particularly immediately below the involucre, bear reddish or golden brown flattened or tubular hairs (Andrews 1990; Bostock & Stokes 1998; Figure 1C, 1D). Despite its distinctiveness from other Victorian ferns, its small size and superficial resemblance to a thallose liverwort when not fertile allow it to be easily overlooked (Garrett 1996). This, combined with its rarity in Victoria, explains why it has only recently been detected in Victoria.

The chloroplast *rbcL* (GenBank MT127786) DNA sequence was obtained for Victorian *H. marginatum* following the protocols outlined in Ohlsen *et al.* (2020), but using the reverse primer 1379R for *rbcL* (Pryer *et al.* 2001). The *rbcL* sequence in the Victorian collection was identical to *rbcL* of *H. marginatum* from southern Queensland (*Perrie L.R. & Ohlsen D.J. BB142*, Springbrook National Park, 28 Aug. 2011, MELU; GenBank MT127787) and the Blue Mountains in New South Wales (*Ebihara 010915-03*, TI; GenBank AB162692). This *rbcL* sequence differs from *rbcL* of its closest known relative, *H. armstrongii* (GenBank AY095109), by nine base pairs,

Table 1. New Victorian records of vascular plant species detected in the past decade.

Species (Family)	First Collection in Victoria	Distribution in Victoria
Sclerolaena cuneata (Chenopodiaceae)	*N.G. Walsh 7297*, 10 July 2011 (MEL 2346330A)	Northern Victoria, Korrak Korrak Nature Conservation Reserve near Kerang
Lythrum wilsonii (Lythraceae)	*N.G. Walsh 7306*, 10 July 2011 (MEL 2346339A)	Northern Victoria, Kerang area
Lythrum paradoxum (Lythraceae)	*E. Obrien s.n.*, 15 Dec. 2011 (MEL 2379882A)	Northern Victoria, Kerang area
Pterostylis acuminata (Orchidaceae)	*W. Probert s.n.*, 17 Apr. 2011 (MEL 2346323A–2346325A)	Far east Victoria, near Genoa Peak
Vittadinia pustulata (Orchidaceae)	*A.R.G. McMahon s.n.*, 4 Oct. 2011 (MEL 2360676A)	Willis, East Victoria and Pira Bushland Reserve, northern Victoria
Brachyscome dichromosomatica (Asteraceae)	*V. Stajsic 6320*, 11 Sep. 2012 (MEL 2363300A)	Neds Corner Station, far northwest Victoria
Acacia linearifolia (Fabaceae)	*K. Goyne s.n.*, 28 Feb. 2014 (CANB 825276.1)	Mount Lawson State Park, far northeast Victoria
Caladenia bicalliata (Orchidaceae)	*D. Pitts s.n.*, 15 Sep. 2015 (MEL 2394759A)	Discovery Bay Coastal Park, far southwest Victoria
Pluchea rubelliflora (Asteraceae)	*C. Moxham s.n.*, 19 Apr. 2018 (MEL 2439613A)	Hattah Lakes National Park, far northwest Victoria
Pterocaulon sphacelatum (Asteraceae)	*K. Bennetts s.n.*, 14 May 2018 (MEL 2439614A)	Kulkyne Station and Lindsay Island, far northwest Victoria
Pomaderris viridis (Rhamnaceae)	*G. Sutter s.n.*, 24 July 2018 (MEL 2434546A)	Near Bellbird Creek, east Gippsland
Hymenophyllum marginatum (Hymenophyllaceae)	*D.J. Ohlsen 1060 et al.*, 22 Dec. 2019 (MEL 2476868A)	Wilsons Promontory National Park, southern Victoria

providing a reliable DNA barcode identification in this instance.

The taxonomy section provides a comprehensive description of *Hymenophyllum marginatum*, compiled using descriptions from several past treatments (Andrews 1990; Wilson 1990; Bostock & Spokes 1998) and incorporating the Victorian collection. Known chromosome numbers, habitat and distribution information, and an assessment of the species' conservation status in Victoria and across its range are also provided.

Taxonomy

Hymenophyllum marginatum Hook. & Grev., *Icon. Filic.* 1: t. 34 (1827); *Pachyloma marginatum* (Hook. & Grev.) Bosch, *Verslagen Meded. Afd. Natuurk. Kon. Akad. Wetensch.* 2: 318 (1861); *Craspedophyllum marginatum* (Hook. & Grev.) Copel., *Philipp. J. Sci.* 67: 27 (1938).

Type: New Holland [Australia], among mosses, *C. Fraser s.n*; lecto: K 001090350!; isolecto: E 00413902!, L 0061092!, NSW 673723!, selected by M.D.Tindale, *Contr. New South Wales Natl. Herb., Fl. Ser.* 201: 21 (1963).

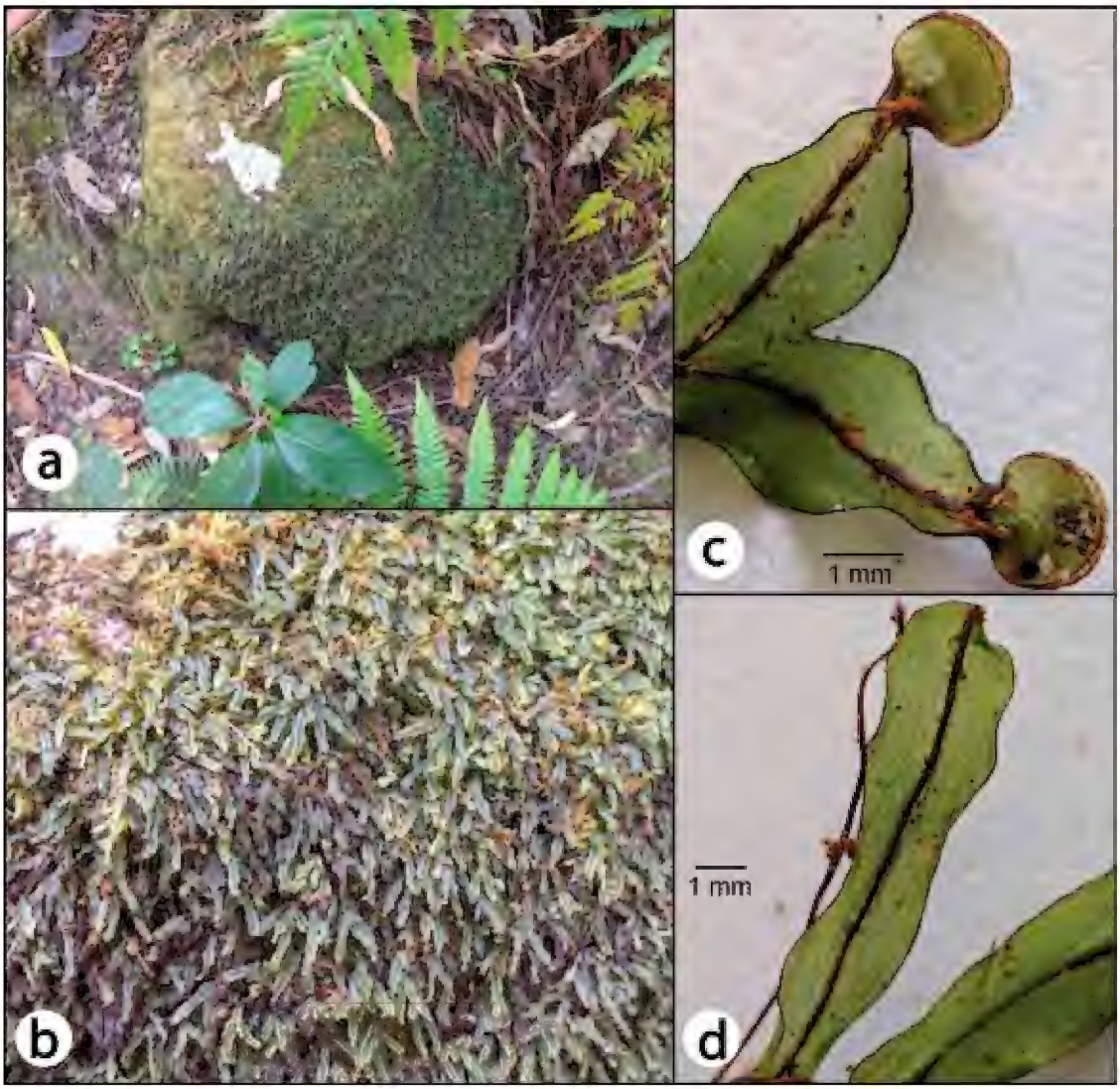

Figure 1. Victorian *Hymenophyllum marginatum* vouchered by *D.J. Ohlsen 1060 et al.* (MEL 2476868A). A. The single rock that bears the Victorian colony of *H. marginatum*; B. Mat of *H. marginatum*; C. A reproductive forking frond; D. A non-reproductive frond and rhizome. All photographs taken by D.J. Ohlsen.

Description

Rhizome long-creeping, filiform, branched, black or dark brown, glossy, with sparse reddish or golden brown hairs (Figure 1D). Fronds 0.35–4.5 cm long (Figure 1B, 1C, 1D). Stipes slender, widely spaced on the rhizome, 0.25–8 mm long, narrowly winged at the apex, usually with a tuft of reddish or golden brown hairs near the base. Lamina simple or 1 (–3)-forked, linear, narrowly oblong to elliptic, 2.5–35 mm, light or dark green, glabrous except for scattered tubular or flattened reddish or golden brown hairs along midrib and at the base of the involucre; simple fronds and lobes 0.7–3(–3.5) mm wide; margins entire, undulate, composed of 1–2 rows of glossy, black cells; apex of non-reproductive lobes rounded, obtuse, rarely acute (Figure 1B, 1C, 1D). Reproductive lobes rounded, truncate or notched; base tapering into the stipe; midrib black, glossy (Figure 1C). Sori borne singly, at the apex of the lamina and/or its lobes; involucre round to ovate, bilabiate to the base or with a very short tube, 0.8–2 mm long; margins entire, composed of a glossy black band 2–3 cells thick; receptacle included (Figure 1C).

Illustrations: E.B. Copeland, *The Philippine Journal of Science* 64: t. 89 (1937); M.D. Tindale, *Contributions of the National Herbarium Flora Series* 201: pl. 2, figs 1–2 (1963); B.D. Duncan & G. Isaac, *Ferns and Allied Plants of Victoria, Tasmania and South Australia* 83, Figure 8.6 (1986); S.B. Andrews, *Ferns of Queensland* 183, Figure 16.8B (1990).

Chromosome Number

$2n = 24$ (S.K. Roy in Tindale and Roy 2002). Hennequin *et al.* (2010) note that *H. marginatum* has $n = 13$ chromosomes, while *H. armstrongii* has $2n = 24$. This is a mix up of counts between the two species as *H. armstrongii* has $n = 13$ (Lovis in Dawson *et al.* 2000).

Distribution

Endemic to Australia. In Victoria known only from the Sealers Cove Walking Track, Wilsons Promontory National Park (*D.J. Ohlsen 1060, L.R. Perrie, L.D. Shepherd & A.A. Neale*, 22 Dec. 2019 (MEL 2476868)). On the mainland, it is also known from the mountains around the Queensland and New South Wales border, in the north, with sporadic occurrences throughout the Great Dividing Range of New South Wales further south, including Mount Banda Banda, the Blue Mountains, the mountains of the Illawarra region and the Budawangs. It is most common and widespread in Tasmania where it has been recorded throughout high-rainfall areas in the west, south and east, as well as on Flinders Island.

Habitat

Wet sclerophyll forest, subtropical and temperate rainforest and on moist rocky outcrops as a lithophyte on sandstone, granite, dolerite, granophyre or rhyolite (latter two for Queensland collections), as an epiphyte on tree ferns, tree bases or logs, or occasionally as a terrestrial (Garrett 1996; Bostock & Spokes 1998; Bostock pers. comm.).

Conservation Status

The one known population of *Hymenophyllum marginatum* in Victoria is confined to a single rock and measures approximately 50 × 30 cm (Figure 1A). The long-creeping rhizome of this species makes it plausible that the total number of plants in Victoria is fewer than 50, which is a threshold number between threatened categories of the IUCN Red List Categories and Criteria (IUCN 2001). However, searches for this species were confined to the walking track and seemingly suitable habitat exists both upslope and downslope of the Sealers Cove Walking Track, making it possible that further colonies exist in the area. A more thorough exploration of these areas should be a priority for future work.

There are several threatening processes that have the potential to cause ongoing decline in the quality of habitat and number of individuals of *Hymenophyllum marginatum* in Victoria, which can be seen in places along the Sealers Cove Walking Track. Some of the wetter gullies, most notably one labelled by Parks Victoria with a wooden signboard as 'Ferny Glade' that may have provided habitat for this species in the past, were largely destroyed by floods in 2011. While the site where *H. marginatum* currently occurs is to the side of a gully, future floods have the potential to erode away the site given the extent of damage that has occurred at some sites in 2011. The Sealers Cove Walking Track is also one of the most popular bushwalking destinations in Victoria, which introduces the threat that the one known colony of *H. marginatum* in Victoria could be trampled by bushwalkers because of its proximity to the walking

track. This threat could be avoided if the walking track were redirected by a couple of metres downslope in the vicinity of the *H. marginatum* population. Fires have also occurred recently in the area. Fires can directly kill ferns or, as in some places along the Sealers Cove Walking Track, they can remove canopy cover, increasing sunlight in the understorey, leading to higher temperatures and drier conditions in the understorey. This has caused a decline in the number and health of some of the other rare fern species (e.g. *Asplenium flaccidum*) along the track (D.J. Ohlsen pers. obs). Prolonged drought is also a threat to *H. marginatum*. Based on the recent discovery of this species in Victoria, it is unknown whether there has been past decline in the number of mature individuals of *H. marginatum* in the state.

Based on all current knowledge of population size and possible threats, *Hymenophyllum marginatum* is designated critically endangered (CR B1ab(iii, v)+2ab(iii, v); C2a(i,ii); D) in Victoria according to the IUCN (2012) criteria. At a national level, it is best considered not threatened according to IUCN (2012).

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Muelleria

39: 15

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ROYAL BOTANIC GARDENS VICTORIA

Afrohybanthus bennettiae (Violaceae) a new combination for a rare violet from the Kimberley region

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Keywords: *Hybanthus*, Taxonomy, Bennett's Violet

At the time of publication of *Hybanthus bennettiae* R.L.Barrett, it was acknowledged that this species and closely allied taxa in the *H. enneaspermus* L. clade as resolved by Wahlert *et al.* (2014) were likely to have a change of generic name (Barrett & Barrett 2015). Around the same time that Barrett's protologue was published, Flicker & Ballard (2015) formalised the proposed taxonomic change to this clade, erecting the genus *Afrohybanthus* Flicker. The very close publication dates of these articles meant that neither author was able to pre-empt and incorporate the others' work into their own at the time of submission. As such, no combination for *Hybanthus bennettiae* exists in *Afrohybanthus*. This new combination is made here.

Afrohybanthus bennettiae* (R.L.Barrett) Messina *comb. nov.

Hybanthus bennettiae R.L.Barrett, *Nuytsia* 26: 81 (2015). *Type:* east of Prince Regent Nature Reserve [National Park] Western Australia, 16.i.2010, *R.L. Barrett 6109, M.D. Barrett & M. Maier* (Holo: PERTH 08614601; iso: CANB, DNA).

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Muelleria

39: 17–26

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ROYAL BOTANIC GARDENS VICTORIA

Pteris epaleata, a new fern species from Australia and New Zealand segregated from *P. comans* (Pteridaceae)

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Introduction

Pteris L. is a large genus of 250 species in Pteridaceae subfamily Pteridoideae that occurs on all continents except Antarctica (Zhang *et al.* 2015; PPG 1 2016). Three subgenera and 15 sections that represent major lineages have been proposed (Zhang and Zhang 2018). The *Pteris comans* G.Forst. subclade is an easily identifiable lineage within subgenus *Campteria*, section *Tripedipteris* (Zhang and Zhang 2018). This group comprises seven species with anastomosing veins from Australia and the Pacific. These are: *Pteris comans*, putatively widespread through the Pacific and south-east Australia, *P. litoralis* Rech., from the tropical Pacific, *P. macilenta* A.Rich., from New Zealand, *P. microptera* Mett. ex Kuhn, from Lord Howe Island, *P. saxatilis* (Carse) Carse, from New Zealand, *P. tahuataensis* Lorence & K.R.Wood, from the Marquesas Islands, and *P. vieillardii* Mett., from New Caledonia. The recently segregated *P. carsei* Braggins & Brownsey, from New Zealand, also belongs here (Brownsey *et al.* 2020). *Pteris laevis* Mett. from New Caledonia and *P. zahlbruckneriana* Endl. from Norfolk Island, which were not sampled by Zhang and Zhang (2018), also have anastomosing veins and are morphologically similar

Abstract

Pteris comans G.Forst. has been broadly circumscribed to encompass a variable assemblage of ferns throughout the Pacific and eastern Australia with anastomosing veins and large, dissected fronds. Populations from the tropical Pacific differ from populations in Australia and New Zealand in frond dissection and indumentum. DNA sequences for the chloroplast loci *rbcL* and *trnL-trnF* were generated to assess their relationships. Australian and New Zealand populations were shown to be more closely related to other New Zealand species than to tropical Pacific *P. comans* and are here described as a new species, *P. epaleata* D.J.Ohlsen.

Keywords: Taxonomy, species complexes, plant systematics, Pteridoideae

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to some of the previously listed species. It is likely that these species also belong to the *P. comans* subclade.

Within the *P. comans* subclade, Zhang and Zhang (2018) recovered two well-supported lineages, one comprising *P. litoralis*, *P. tahuataensis* and *P. microptera* and the other comprising Australian *P. comans*, *P. carsei* (included at the time under *P. comans*), *P. macilenta* and *P. saxatilis*. *Pteris vieillardii* was sister to these two clades (Zhang and Zhang 2018). *Pteris carsei* (then included in a broader *P. comans*) was shown to be more closely related to *P. macilenta* and *P. saxatilis* than it was to Australian *P. comans*, supporting previous suggestions that the *P. comans* group required taxonomic revision (Green 1994). This revision was undertaken in part by Brownsey *et al.* (2020), who described *P. carsei*, which was a step toward restoring monophyly of species within the *P. comans* subclade. Brownsey *et al.* (2020) also detailed how *P. carsei* and other recognised species in the *P. comans* subclade can be distinguished morphologically, by a combination of frond size, dissection and indument. This showed that narrowly defined species delimitations in the *P. comans* subclade, although followed with hesitation in the past (Green 1994), could be both monophyletic and morphologically recognisable.

Pteris comans still remains a rather broadly circumscribed species even with the exclusion of *P. carsei*. In its current circumscription it is also far more widespread than the other species of the *P. comans* subclade, being recognised in subtropical and temperate south-east Australia, as well as throughout the tropical Pacific in the Solomon Islands (Chen *et al.* 2017), Vanuatu (Nakamura 2008) where the type was collected (Nicolson and Fosberg 2003; Brownsey *et al.* 2020), New Caledonia (Brownlie 1969), Fiji (Brownlie 1977), Samoa (Christensen 1943), Tonga (Yuncker 1959), Cook Islands (Sykes 2016) and French Polynesia (Brown and Brown 1931; Lorence *et al.* 2011). There are two clear morphological forms that currently reside within *P. comans*. Populations from Australia have more dissected fronds, being 3–4-pinnate-pinnatifid with pinnatifid segments near the apex, whereas populations in the tropical Pacific have fronds that are at most 3-pinnate-pinnatisect at the base and have segments towards the apex that remain more or less entire. Retaining this level of morphological heterogeneity within the one species is inconsistent with the trend of adopting narrower species concepts for the rest of the *P. comans* subclade.

Brownsey *et al.* (2020) suggested that mainland Australian and Tasmanian *P. comans* may be better treated as a separate species with *P. comans s.str.* only occurring in the tropical Pacific, but did not conduct any formal revision on the Australian plants. In the current study, morphological and chloroplast DNA variation is assessed across the distribution of plants formerly assigned to *P. comans*, including populations from across Australia and also from the tropical Pacific, as well as two collections from Fiordland, New Zealand, that are morphologically similar to Australian plants. This was done to aid taxonomic judgement on whether *Pteris comans* should be retained as a single variable and widespread species or whether some populations would be better treated as a separate species.

Materials and methods

DNA Isolation and amplification

Fifteen new DNA sequences belonging to the *P. comans* subclade were generated in this study (Table 1). The methods either followed Shepherd *et al.* (2019) or were as described here. DNA was extracted from 20 mg of silica gel-dried young leaf tissue. Leaf tissue was ground using a mortar and pestle with the aid of acid-washed grinding sand (Ajax Finechem, Aus). DNA was isolated from ground samples using a DNeasy Plant Mini Kit (QIAGEN, Germany), following the manufacturer's instructions. DNA was eluted in 100 µL of the supplied elution buffer.

Samples were sequenced for the chloroplast regions *rbcL* and *trnL-trnF*. These regions were chosen because several species of the *P. comans* subclade have been previously sequenced for *rbcL* (Chao *et al.* 2014; Zhang *et al.* 2015; Zhang and Zhang 2018) allowing easy comparison, and *trnL-trnF* is a region routinely employed in studies of fern systematics because it contains non-coding regions that have demonstrated high levels of genetic variation in fern species (e.g. Su *et al.* 2005; Shepherd *et al.* 2007; Wang *et al.* 2011). A herbarium specimen from Fiordland, New Zealand (*Johnson s.n.*, CHR 253997) suspected of being more closely related to Australian populations than other New Zealand

populations, some herbarium samples of *P. carsei* and two silica-gel dried samples of *P. comans* specimens from the Solomon Islands were sequenced for *trnL-trnF* but efforts to amplify *rbcL* were unsuccessful.

Chloroplast DNA markers were amplified by Polymerase Chain Reaction (PCR), performed on a MyCycler thermal cycler (Bio-Rad, USA). Reaction mixtures comprised 5 µL of 5x MyTaq Reaction Buffer containing 5 mM of each dNTP and 15 mM $MgCl_2$ (Bioline, Australia), 0.125 µL (0.625 units) MyTaq DNA Polymerase (Bioline, Australia), 10 pmol of each primer, 2.0 µL of extracted DNA, and distilled water added to make a total volume of 25 µL. The *trnL* intron, *trnL* 3′-exon and *trnL-trnF* intergenic spacer were amplified and sequenced using the primers F (5′-ATT TGA ACT GGT GAC ACG AG-3′) (Taberlet *et al.* 1991) and Fern1 (5′-GGC AGC CCC CAR ATT CAG GGR AAC C-3′) (Trewick *et al.* 2002). The *rbcL* gene was amplified using the primers aF (5′-ATG TCA CCA CAA ACA GAG ACT AAA GC-3′) and cR (5′-GCA GCA GCT AGT TCC GGG CTC CA-3′) (Hasebe *et al.* 1994).

PCR thermocycling conditions involved an initial denaturation step of 95°C for 1 minute, followed by 33 cycles of 95°C for 1 minute, 55°C for 1 minute, and 65°C for 4 minutes, and a final extension at 65°C for 5 minutes. PCR products were quantified by electrophoresis against Hyperladder I and EasyLadder I (Bioline, Australia) and purified using illustra ExoSTAR 1-step enzymatic purification (GE Healthcare Life Sciences, UK). Purified PCR products were then sent to the Australian Genome Research Facility (AGRF), Melbourne Branch, where sequencing reactions, and capillary separation, using the 96-capillary analyser AB 3730*xl* sequencing platform, were performed.

Sequence editing, alignment and analysis

Sequences were edited using Sequencher v. 4.9 (Gene Codes Corporation, Ann Arbor, MI, USA) and were aligned manually in Se-Al Sequence Alignment Editor v. 2.0a11 (Rambaut 2002). Maximum Parsimony analysis was performed in PAUP* v. 4.0 β10 (Swofford 2002). Gap characters in the alignment were treated as a fifth

Table 1. Details of samples used in phylogenetic analyses. Newly generated sequences are given in bold. A '-' is given for samples for which *rbcL* was not generated.

Species	Specimen Details	*rbcL* GenBank Number	*trnL-trnF* GenBank Number
Pteris carsei	New Zealand, Waitakere Ranges, *L.R. Perrie 3406 & L.D. Shepherd* (WELT P020796)	EF469954	**MT180118**
	New Zealand, Great Barrier Island, *M.E. Young s.n.* (AK 298327)	GU136796	**MT180117**
	New Zealand, Kermadec Islands, Raoul Is., *E. Cieraad s.n.* (WELT P020739)	-	**MT180120**
	New Zealand, Whangarei, *L.R.Perrie 4661 & L.D. Shepherd* (WELT P029533)	-	**MT180119**
P. comans	Solomon Islands, Kolombangara Is., *C.-W. Chen et al. Wade2727* (TAIF 445137)	-	**MT180113**
	Solomon Islands, Nggatokae Is., *C.-W. Chen et al. Wade3238* (TAIF 452521)	-	**MT180112**
P. epaleata	Australia, Victoria, Main Creek, *D.J. Ohlsen 913 & V. Stajsic* (MEL 2469967A–2469973)	**MT180110**	**MT180115**
	Australia, Queensland, Toolona Circuit Track, *L.R. Perrie & D.J. Ohlsen BB122* (MELUP 118484)	**MT180109**	**MT180114**
	New Zealand, Fiordland, Resolution Island, *P.N. Johnson s.n.* (CHR 253997)	-	**MT181523**
P. macilenta	New Zealand, Pohangina Valley, *L.R. Perrie 3770* (WELT P021006)	GU136797	**MT180121**
P. saxatilis	New Zealand, Aranga Beach, *L.R. Perrie 3662* et al. (WELT P022567)	GU136798	**MT180122**
P. tahuataensis	French Polynesia, Marquesas Islands, *K. Wood 10250* (PTBG)	MF972821	MF972861
P. vieillardii	New Caledonia, Plateau de Dogny, *L.R. Perrie 7696 et al.* (WELT P028681)	**MT180111**	**MT180116**

character state. For indels of multiple-bases, characters were excluded from analysis so that indels were each represented only by a single gap character. Samples for which *rbcL* could not be generated had their *rbcL* section of the alignment scored as missing data. A heuristic tree search was used, with delayed character-state optimisation (DELTRAN) and starting trees were obtained by a closest addition sequence, followed by tree bisection-reconnection (TBR) branch swapping. Bootstrap support for nodes was determined using 1000 'full heuristic' replicates. *Pteris vieillardii* was chosen as an outgroup because this species is sister to the remaining species of the *P. comans* subclade (Zhang and Zhang 2018).

Morphological Observations

All herbarium material belonging to the *P. comans* subclade was inspected in the home herbaria of the authors (MEL, MELU, TAIF and WELT) along with all material in AK and CHR. This covers around 30% of all Australian *Pteris comans* specimens in herbaria and was expected to be representative of the morphological diversity harboured within Australian *P. comans*. All online images of types of species in the *P. comans* subclade, including *P. comans*, were also viewed. Morphology that is variable among the *P. comans* subclade, such as frond size, dissection, colour, and indumentum, was a focus for assessing any possible major morphological forms that could be residing within *P. comans s.lat.*, and a new description was written based on herbarium specimens seen, augmented by ranges reported in existing descriptions (e.g. Kramer and McCarthy 1998).

Results and Discussion

Both Australian populations of the new species had identical *rbcL* sequences but differed in their *trnL-trnF* sequences by one base substitution and one nucleotide in a mononucleotide repeat. The *trnL-trnF* sequence from the collection from Fiordland, New Zealand (*Johnson s.n.*, CHR 253997) was identical to *trnL-trnF* of the Victorian population except for a difference of one nucleotide in a mononucleotide repeat. This is a similar amount of genetic variation to what is harboured in *P. carsei*, which had two base substitution differences between the two *rbcL* sequences, and one base substitution difference and slight differences in length of mononucleotide repeats among the four *trnL-trnF* sequences.

Twenty-six most parsimonious trees that were 63 steps long were generated, one of which is shown in Figure 1. Clades with strong support (bootstrap of at least 80%) were also recovered in all trees not shown and so the following discussion of the results of the presented tree apply to all 26 most parsimonious trees. Australian populations and the Fiordland sample of *P. comans* were resolved as sister to a clade of *P. carsei*, *P. macilenta* and *P. saxatilis*, the same relationship found by Zhang and Zhang (2018) using a single Australian sample of *P. comans* and a different set of DNA regions. The *P. comans* sample from the Solomon Islands was sister to *P. tahuataensis* (Figure 1), making *P. comans* in its current circumscription polyphyletic. It is also likely that *P. comans* from the Solomon Islands is closely related to *P. litoralis* and *P. microptera* given that these species were in a well-supported lineage with *P. tahuataensis* based on a different set of chloroplast regions (Zhang and Zhang 2018). *Pteris carsei* did not form a clade separate from the other New Zealand species due to a lack of genetic variation between samples. It is likely that these species share a recent ancestry and that *P. macilenta* is an allopolyploid derived from *P. carsei* and *P. saxatilis* (Braggins 1975; Brownsey and Smith-Dodsworth 2000). All three species are morphologically distinct in New Zealand (Brownsey and Smith-Dodsworth 2000) and the lack of resolution between these species in the tree is not taken here to reflect a need for taxonomic re-evaluation of these species.

All mainland Australian and Tasmanian specimens of *P. comans* examined and two collections from Fiordland in New Zealand (Resolution Island, *Johnson s.n.*, CHR 253997; Coal River, *Johnson s.n.*, CHR 320041) shared a similar set of morphological features, including having highly dissected fronds that were at least 3-pinnate throughout the lower half of the frond and 3-pinnate-pinnatifid at the base (Figure 2A), dull green to yellow-green fronds (Figure 2A), hairy pinnae, and costae that may occasionally have linear scales 2–3(–4) cells wide (Figure 2B, 2C). This combination of features distinguishes this group of populations from other members of the *P. comans* subclade, including *P. comans* from the tropical Pacific (see Recognition section below

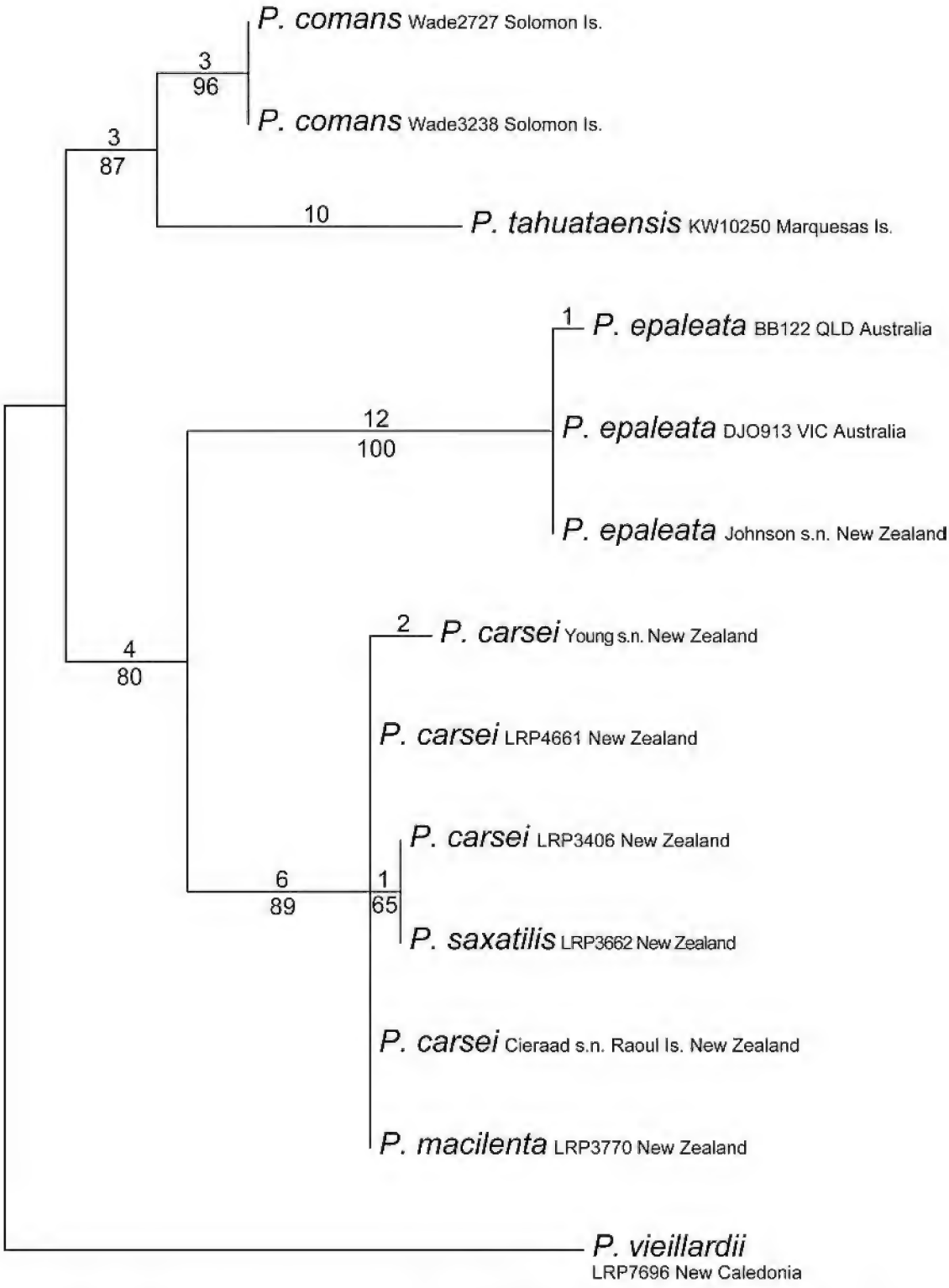

Figure 1. One of 26 most parsimonious trees (length = 63, CI = 0.968, RI = 0.965). Branch lengths are given above branches and bootstrap support is given below branches.

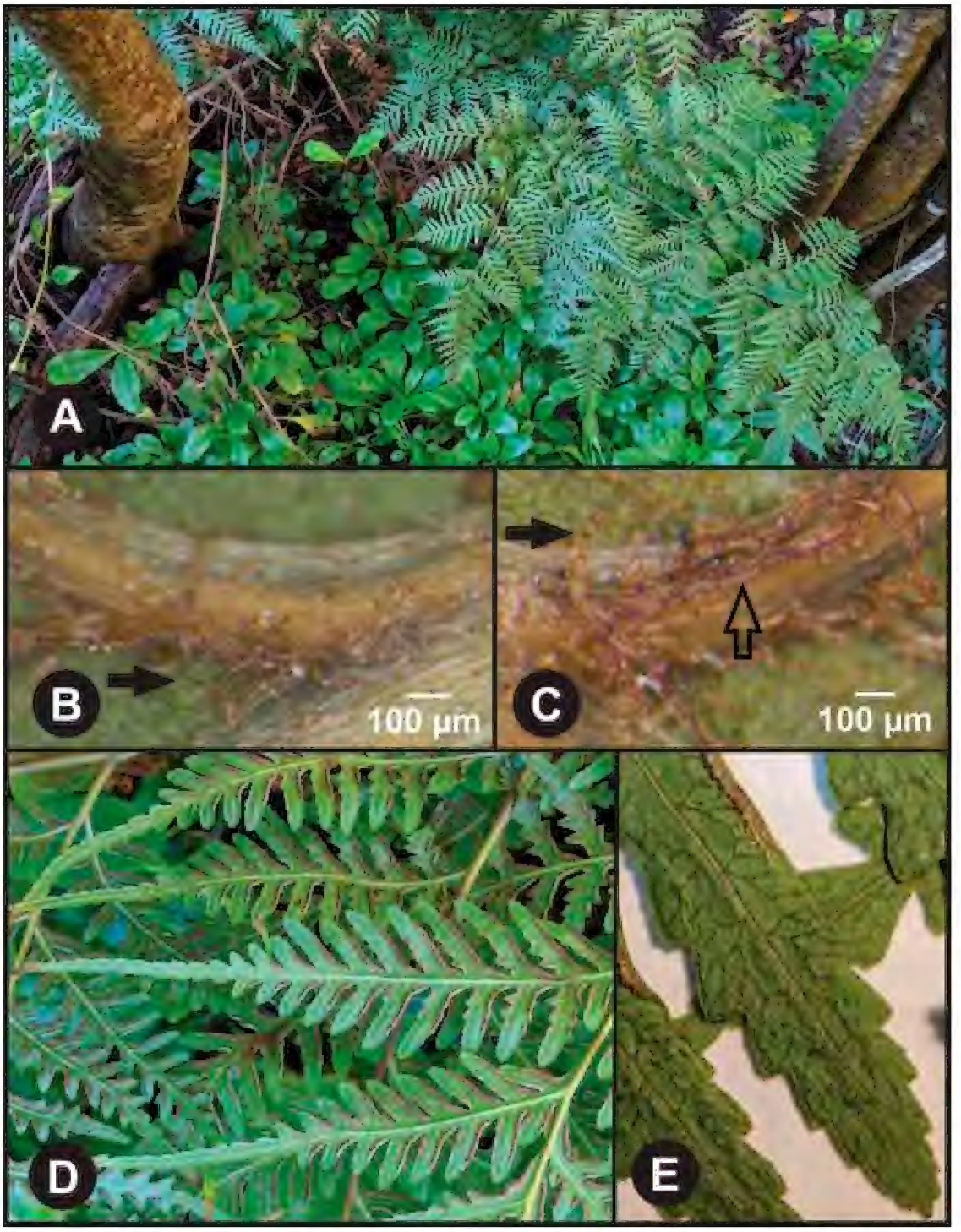

Figure 2. Morphology of *Pteris epaleata* based on the living plant of *D.J. Ohlsen & V. Stajsic DJO913*.
A. Frond from above. **B.** Abaxial lamina and costules showing typical indument and with the arrow pointing to a uniseriate hair. **C.** Abaxial lamina and costule with the open arrow pointing to an example of a rare linear hair-like scale. The filled-in black arrow points to a hair for comparison. **D.** Abaxial surface of secondary pinnae. **E.** Tertiary pinna showing the anastomosing venation.

for more details). No specimens from mainland Australia or Tasmania examined possessed the diagnostic features of closely related species in the *P. comans* subclade such as *P. carsei*.

The morphological observations and genetic results support recognition of all mainland Australian and Tasmanian specimens examined and the Fiordland specimens as a single species. They are all unified by a set of morphological features, there are no distinctive morphological variants that can be easily discerned among these specimens, and geographically-distant samples have been shown to share very similar *rbcL* and *trnL-trnF* sequences. The results of this study also support the recognition of these populations as a separate species from *P. comans* in the Solomon Islands, given that the *P. comans* samples are polyphyletic and populations from the tropical Pacific can be easily distinguished morphologically from the populations in mainland Australia, Tasmania and Fiordland. The Solomon Islands specimens are morphologically similar to the type from nearby Vanuatu, making it very probable that our Solomon Islands samples are representative of *P. comans s.str.* The two species also appear to be geographically disjunct as the *P. comans* subclade has not been recorded from the intervening wet tropics region of north-east Queensland. Consequently, the following taxonomy section describes the populations in mainland Australia, Tasmania and Fiordland as the new species, *P. epaleata* D.J.Ohlsen, with *P. comans* now being restricted to the tropical Pacific.

Taxonomy

Pteris epaleata D.J.Ohlsen sp. nov.

Etymology

Epaleata is Latin (feminine, nominative case) for without scales, which refers to the absence of well-developed triangular scales on the lamina, a feature that helps to distinguish this species from the closest related species.

Holotype

Australia, Victoria, Mornington Peninsula National Park, Main Creek south of Boneo Road, 30 August 2019, *D.J. Ohlsen & V. Stajsic DJO913* (MEL 2469967A–2469973A). Isotypes: CANB, NSW, WELT.

Description

Rhizomes erect, scaly. Rhizome scales narrowly ovate, 7–8 mm long, c. 2 mm wide, pale brown, concolorous, lacking marginal projections. Fronds (Figure 2A) 77–174(–250) cm long. Stipes 40–103(–140) cm long, 6–11 mm diameter near the base, purplish-brown, red-brown or chestnut-brown proximally, yellow-brown or chestnut-brown distally, occasionally with scattered scales proximally. Rachises yellow-brown or chestnut-brown, adaxially sulcate, glabrous. Laminae 3–4-pinnate-pinnatifid at base, broadly ovate, 33–75(–110) cm long, 30–100 cm wide, dark green and dull adaxially, paler abaxially, herbaceous, bearing multicellular hairs (Figure 2B, 2C) and occasionally hair-like linear scales 2–3(–4) cells broad (Figure 2C) on the costae; veins anastomosing. Primary pinnae in 5–11 pairs below pinnatifid apex, overlapping; the longest at or near the base, 12–58 cm long, 12–28 cm wide, elliptic or narrowly- to broadly-ovate, straight; pinna apices acute to acuminate, bases long-stalked. Longest secondary pinnae (Figure 2D) 10–27 cm long, 5–15 cm wide, usually narrowly ovate, sometimes ovate, subopposite at base becoming alternate toward apex of primary pinnae, longest at base to midway along primary pinnae and then becoming gradually smaller toward apex, apices acute to acuminate, bases adnate or stalked. Longest tertiary segments (Figure 2E) 15–90 mm long, 5–30 mm wide, elliptic, ovate or oblong; apices acute to obtuse, margins crenate, serrate or divided to more than halfway, bases adnate or shortly stalked. Quaternary segments to 22 mm long, 2–9 mm wide, oblong to triangular, apices acute to obtuse, margins crenate, serrate or divided to more than halfway, bases adnate, occasionally with further divisions to 4 mm long, 1–3 mm wide; ultimate segments 1–5.5 mm wide. Sori elongated along margins of the ultimate segments, with paraphyses among sporangia; indusia 0.35–0.55 mm wide. Spores 25–35 µm in polar diameter, 35–47.5 µm in equatorial diameter.

Specimens examined: QUEENSLAND: Binna Burra, *N.A. Wakefield 425*, 13 Nov. 1942 (MEL); Lamington National Park, Toolona Circuit Track, *L.R. Perrie & D.J. Ohlsen BB122*, 29 Aug. 2010 (MELU; BRI). **NEW SOUTH WALES:** Deervale, *N.A. Wakefield 144*, 5 Jan. 1941 (MEL); Mount Dromedary, *N.A. Wakefield 143*, 12 Jan. 1941 (MEL); Belmore Falls, *E.F. Constable 6251*, 14 Oct. 1965 (MEL); Dawsons Springs, Mount Kaputar

National Park, *R.G. Coveny 8707*, 17 Nov. 1976 (MEL); Brindle Creek, *R.G. Coveny 9949*, 4 Dec. 1977 (MEL). **VICTORIA:** Cape Otway, *C. Walter s.n.*, 1 Dec. 1873 (MEL); Joanna River, *C. Walter s.n.*, 1 Mar. 1874 (MEL); Ferntree Gully, *P.R.H. St John s.n.*, 20 Sep. 1906 (MEL); Apollo Bay, *S.G.M. Fawcett s.n.*, 31 May 1955 (MELU); Clematis Gully, Dandenong Ranges, *O. Singleton s.n.*, 18 Apr. 1943 (MEL); Hardy's Gully, Kallista, *R. Melville 3838*, 11 May 1953 (MEL); Reserve opposite Tarra National Park, *G. Isaac s.n.*, 2 Nov. 1975 (MEL); Sherbrook Forest, *P.K. Gullan & A.M. Opie 44*, 23 Feb. 1977 (MEL); Nepean State Park, along a tributary of Main Creek, c. 0.75 miles from its junction with Lightwood Creek, *W.R. Archer s.n.*, 13 May 1979 (MEL); Tributary of Main Creek, *B.D. Duncan 79143*, 28 Aug. 1979 (MEL); Tributary of Main Creek, *B.D. Duncan 79144*, 28 Aug. 1979 (MEL); Willies Gully, tributary of Main Creek, *B.D. Duncan s.n.*, 28 Aug. 1979 (MEL); Near Sherbrook-Kallista Road, *B.D. Duncan 80056*, 21 Mar. 1980 (MEL); Near the junction of Main Creek and small tributary, *L.K.M. Elmore s.n.*, 1 Sep. 1980 (MEL); Tributary of Main Creek, *W. Archer BDD 81063*, 15 Feb. 1981 (MEL); Northern heathlands, Wilsons Promontory, *E.A. Chesterfield 2061*, 19 Nov. 1987 (MEL); Highfield State Park, tributary flowing into Main Creek, N of Boneo Road, S of Lightwood Creek, *J. Westaway 601*, 23 Jan. 1989 (MEL); Minor Gully draining into Main Creek south of Boneo River [Road], *J. Westaway 606*, 24 Jan. 1989 (MEL); Wongungurra River upstream from Blowfly Creek junction, *G. Johnson 263*, 3 Dec. 1996 (MEL); Warnambool-Cobden Rd, *L. Weedon s.n.*, 8 Dec. 2011 (MEL); 15 metres above west Bank of Main Creek, south of Boneo Road, *D.J. Ohlsen BB245*, 9 Sep. 2012 (MELU); N-S tributary of Main Creek, c. 110 metres ESE from Bushrangers Bay Walking Track, *V. Stajsic 9059*, 14 Mar. 2019 (MEL); Main Creek south of Boneo Road, *D.J. Ohlsen & V. Stajsic* DJO913, 30 August 2019 (MEL). **TASMANIA:** Between Circular Head and the Arthur River, *F. Mueller s.n.*, 1 Feb. 1875 (MEL); Golden Valley, *R.A. Black s.n.*, 6 Apr. 1915 (MEL); Cumberland Creek, King Island, *P. Barnett s.n.*, 12 June 1967 (MEL); Little Beach Creek, *M. Garrett s.n.*, 1 July 1984 (MEL); Blackwater Road, Spur 5, *G. Kantvilas 90*, 15 Sep. 1984 (MEL). **NEW ZEALAND:** Resolution Island, Fiordland, *P.N. Johnson s.n.*, Dec. 1974 (CHR); Coal River, Fiordland, *P.N. Johnson s.n.*, 8 Nov. 1977 (CHR)

Chromosome Number

2*n*=58 (S.K. Roy and B.G. Briggs in Tindale and Roy 2002, as *Pteris comans*).

Distribution

Australia and New Zealand. In Australia it is sporadically distributed from south-east Queensland south to Tasmania. In Queensland it is known from Lamington National Park near the border with New South Wales. In New South Wales it occurs on and east of the Great Dividing Range but with an inland occurrence at Mount Kaputar. In Victoria it occurs south of the Great Dividing Range and extends west to around Warnambool. It is widespread throughout Tasmania. In New Zealand it is only known from two collections from Fiordland National Park, where it may be a relatively recent arrival by long-distance dispersal similar to *Sticherus tener* (R.Br.) Ching (Brownsey *et al.* 2013).

Habitat

Pteris epaleata is a terrestrial fern found in subtropical to cool-temperate rainforest and wet-sclerophyll forests usually along creeks or muddy drainage lines, but sometimes also at the base of cliffs or on outcrops in areas of water seepage. It grows from sea-level to around 1100 metres on the east edge of the New England Plateau in New South Wales.

Recognition

Pteris epaleata resembles several species of the *Pteris comans* subclade *sensu* Zhang and Zhang (2018). *Pteris epaleata* differs from all of these species by indumentum and frond division. The indumentum on the abaxial side of the rachis, costae and costules in *Pteris epaleata* comprises uniseriate hairs or sometimes also very occasional linear scales that are 2–3(–4) cells broad at the base (Figure 2B, 2C). In morphologically similar species, such as *P. carsei*, *P. microptera* and *P. zahlbruckneriana*, the rachis and costae have uniseriate hairs and some triangular scales that are several cells wide at the base or in the case of *P. comans s.str.* are glabrous. *Pteris epaleata* can be further distinguished from the other species that have been included in *P. comans* by its more divided fronds that are at least 3-pinnate throughout the lower half of the frond and 3-pinnate-pinnatifid at the base, with the segments adnate to the rachis near the apex being pinnatifid (Figure 2A). In this respect it resembles *P. tremula* R.Br., which has free venation and is not part of the *P. comans* subclade (Zhang and Zhang 2018). The other species that have been included in *P. comans* are 2-pinnate-pinnatifid or less divided or are more divided only in the basal primary pinnae, and the segments adnate to the rachis near the apex have at most small teeth near their apices rather than being incised along

the entire margin of the segment. *Pteris epaleata* can be further distinguished from *P. carsei* and from *P. macilenta* and *P. saxatilis* by its dull adaxial frond surface compared with the lustrous adaxial frond surface in *P. carsei*. *Pteris carsei* also usually has broader ultimate segments (4–28 mm wide) than *P. epaleata* (1–5.5 mm wide) and *P. carsei* is confined to coastal areas, whereas *P. epaleata* can extend further inland, including into mountainous areas.

Hybridisation

A collection from Mount Elephant in eastern Tasmania (*Garrett s.n.* HO 326490) has been claimed by the collector on the sheet to be a hybrid between *P. epaleata* and *P. tremula*, which are both much more abundant than the putative hybrid at that site.

Conservation Status

In the Victorian part of its range, *P. epaleata* has been classified as rare on the basis of relatively few known populations (Gullan *et al.* 1990). Globally, it is probably best considered not threatened under IUCN Red List Threatened Species criteria. In New Zealand, because there has been no targeted surveying, we suggest a provisional assessment under Townsend *et al.* (2008) as Data Deficient with the qualifier Secure Overseas.

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ROYAL BOTANIC GARDENS VICTORIA

Comparative floral traits in *Corunastylis* (Diurideae; Orchidaceae) with novel applications: do some species bleed or blink?

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Introduction

True flies (Diptera) are the primary pollinators of many species within the family Orchidaceae (Dressler 1993; Larson *et al.* 2001). However, some fly pollinators are < 3 mm in length. These micro-dipterans belong to members of the families Ceratopogonidae, Chloropidae, Culicidae, Drosophilidae, Milichiidae, Mycetophilidae, Phoridae, Scatopsidae and Sciaridae (Thien 1969, Larson *et al.* 2001; Kuiter 2016). Many Neotropical orchids in the subtribe Pleurothallidinae (Epidendroideae; *sensu* Neyland *et al* 1995) are pollinated by micro-dipterans in different families. Floral variation within pleurothallid lineages indicates complex biochemical and morphological modifications in the evolution of attractants, rewards and/or suites of traits indicative of sexual mimesis (Borba & Semir 2001; Blanco & Barboza 2005; Karremans *et al.* 2015; Bogarin *et al.* 2018).

Australia is also a centre of orchid pollination by micro-dipterans. Weston *et al.* (2014) reviewed floral evolution in indigenous species in the tribe Diurideae and found that some species in the genera *Acianthus*,

Abstract

We compared suites of inflorescence and floral traits of six taxa in the genus *Corunastylis*. Liquid rewards were not detected at the bases of labellum calluses in three species. Instead, glabrous auricle lobes containing variable numbers of raphides secreted droplets. Scent analyses identified seven compounds in three species, with five for *C. ruppii*, sharing 8-heptadecene with *C. filiformis*. A previous hypothesis that these flowers mimic wounded insects offering "mock haemolymph" overlaps with the suggestion here that scents and trembling labella mimic blinking, weeping eyes.

Keywords: *Corunastylis*, auricles, labellum, mimicry, raphides, staminodes

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Corybas (as *Corysanthes s.s.* and *Singularybas*) and *Rhizanthella* (*sensu* Jones 2006) required pollinators belonging to one to four families containing micro-dipterans. In addition, members of the Australasian genus *Pterostylis* (Cranichideae) and its allies were pollinated by small flies in the Mycetophilidae and Sciaridae (Gaskett 2011; Kuiter 2016). Most of these Australasian species bloom only in the temperate, Australian winter into mid-spring (Jones 2006).

The Australasian genus *Corunastylis* (*sensu* Clements & Jones 2002; Clements *et al.* 2002; Jones *et al.* 2002) contains over 50 species (Jones 2006; Jones & Clements 2018) and is also dependent on micro-dipterans. However, micro-dipteran pollination in *Corunastylis* species appears to differ from the other Australasian genera in five ways. First, the majority of *Corunastylis* species bloom from summer into mid-autumn. Second, they present non-resupinate flowers. Third, they may be the only taxa in temperate Australia to be pollinated primarily by members of the Chloropidae and, to a lesser extent, by the Miliichidae and Scatopsidae (Weston *et al.* 2014; Bower *et al.* 2015; Kuiter 2016, 2018). Fourth, the flowers of many *Corunastylis* species have a floral organ that Garnet (1940) referred to as the "comically tremulous labellum." That is, the labellum is attached to a column foot by such a thin hinge that it flaps or trembles in the slightest breeze. Fifth, while most *Corunastylis* species present labellum surfaces that show dark pigmentation, calluses, and are bearded-ciliate, there is no evidence that they mimic brood-sites, edible resources or sexually receptive females. Floral scents, when recorded at all, were described previously as lemon-scented in four species (Blaxell 1970; Jones 2006), musty and unpleasant for *C. bishopii* (D.L.Jones & M.A.Clem.) D.L.Jones & M.A.Clem (Jones 2006) or reminiscent of sour milk for *C. archeri* (Hook.f.), D.L.Jones & M.A.Clem (Blaxell 1970).

Descriptions of pollination of *Corunastylis* species began with Garnet (1940), who studied four wild-collected species grown on in pots on windowsills. He recorded nectar droplets at the bases of the two labellum calluses and observed the removal of pollinaria of *C. archeri* and *C. morrisii* (Nicholls) D.L.Jones & M.A.Clem. by small flies. These insects were placed in the family Chloropidae and identified as members of the genera *Caviceps s.l.* and *Oscinosoma*, now placed within the austral genus *Gaurax*. The field study by Bower *et al.* (2015) of the rare *C. littoralis* (D.L.Jones) D.L.Jones & M.A.Clem. (syn. *Genoplesium*) also found pollinators in two genera in the Chloropidae (*Conioscinella* and *Cadrema*). They photographed nectar droplets in the grooves of the labellum callus. Although most chloropid specimens bearing pollinaria were females, the authors did not interpret *C. littoralis* as a brood-site mimic due to the absence of eggs in the flowers and the lack of discernible dung or carrion-like scents. However, many members in the Chloropidae do not oviposit in dung or corpses. Instead, the maggots of some species consume a wide variety of plant or animal resources (Arnett 1985).

Literature on the role of chloropids as pollinators remains uncommon (Larson *et al.* 2001; Oelschlagel *et al.* 2015; Kuiter 2016; Wiesenborn 2016). In particular, there is a lack of information regarding intra- and interspecific variation in traits offering attractants and rewards to chloropids visiting flowers of *Corunastylis* species. This includes the investigation and clarification of the number of flowers per inflorescence (display), histology, scent analyses and the prospective location of rewards in understudied species. Our results will be used to propose a novel hypothesis for pollination syndromes in some members of this genus.

Methods

Study sites, observation and collection dates

Flowers of *Corunastylis* were observed and collected in New South Wales and Victoria. To protect extant populations from poaching, GPS coordinates are withheld following the Sensitive Species Data Policy in New South Wales (Andrews 2009) along with detailed descriptions of vegetation. We sampled the following sites containing the following species.

1. NEW SOUTH WALES. Arcadia: Bloodwood Road. Collection of inflorescences of *C. fimbriata* (R.Br.) D.L.Jones & M.A.Clem (10/01–22/02/2016) in ridgetop open *Eucalyptus* woodland with shrubby understory.
2. NEW SOUTH WALES. Ku-ring-gai Chase National Park. Collection of inflorescences of *C. fimbriata* and *C. ruppii* (10/01–29/02/2016) along track bordered by *Banksia* woodland.

3. NEW SOUTH WALES. Kulnura. Collection of inflorescences of *C. filiformis* and *C. ruppii* (R.S.Rogers) D.L.Jones & M.A.Clem (05/02–18/03/2016) along graded, roadside verges bordering sclerophyll shrublands and farms.
4. NEW SOUTH WALES. Royal National Park. Collection of inflorescences of *C. filiformis* and *C. rufa* (R.Br.) D.L.Jones & M.A.Clem (19/02/2016) along the margins of a fire trail in a slashed powerline easement through shrubby sub-formation of dry sclerophyll forest.
5. NEW SOUTH WALES. Heathcote National Park. Collection of *C. filiformis* (Fitzg.) D.L.Jones & M.A.Clem (11/03/2017) in dry, sclerophyll forest with coastal sandstone ridgetop woodland community. Specimens were collected only for additional microscopy on column wing histology (see *Results* and *Discussion*).
6. VICTORIA. Langwarrin Flora & Fauna Reserve and Crib Point. Collection of inflorescences of *C. archeri*, *C. ciliata* (Ewart & B.Rees) D.L.Jones & M.A.Clem, *C. archeri* × *C. ciliata*. and *C. morrisii* (7/04/2016) in paddocks, verges and lawns of Eurasian grasses and forbs.

Comparative flowering periods and the number and development of flowers on inflorescences

Flowering periods for the populations from which collections were made were recorded from 2015–2016, and again in 2019 for *Corunastylis ruppii* at Kur-ring-gai Chase. Inflorescences were selected at random, and the number of flowers per inflorescence counted using 3× optical glass binocular magnifiers (Opti Visor, Donegan Optical Co.) or by placing whole, collected scapes under a dissecting microscope following fixation in 3:1 95% ethanol:glacial acetic acid. Patterns of floral development (open or closed) and the order of flower bud opening (synchronous, acropetal or basipetal) were recorded. Although it was estimated that the population of *C. ciliata* contained >300 scapes in 2016, all were in different stages of fruiting. To determine the original number of flowers on inflorescences in this species, the number of withered flowers, fruits and flower scars on each scape were also counted.

Labellum observations

The trembling of labella of open flowers in the wind was analysed in several species and one putative hybrid. This also included probing the labella of whole flowers on inflorescences under a dissecting microscope. Labellum calluses were examined for the presence of nectar droplets in open flowers of *Corunastylis filiformis, C. fimbriata* and *C. ruppii*, isolated under organza bags. To stabilise the slender scapes, a bamboo skewer was inserted into the earth next to each inflorescence while it was still in bud. The whole inflorescence and skewer were covered with an organza bag. The skewer served to prop up the bag so that the weight of the bag was never set upon on the scape. The bag was removed to examine open flowers 24–48 hours following anthesis and after the evaporation of morning dew. Specimens were also collected of *C. fimbriata* and *C. ruppii* found severed and lying on the ground, presumably through damage by unknown animals. At field sites, buds and flowers were viewed while wearing an Opti Visor.

Secretion in column appendages

Terminology. Previous and unpublished observations, by W. Grimm on *Corunastylis fimbriata*, and on *C. filiformis* by B. Towle, suggested that the column appendages (*sensu* Nicholls 1969) of these species contained secretory structures. Each pair of column appendages in a *Corunastylis* flower is bilobed and the lobes are fused at their bases. They are often referred to as anterior and posterior lobes, but the terms were deemed inadequate and confusing in non-resupinate flowers. Therefore, the terminology of Kurzweil *et al.* (2005) was adopted, subdividing the two appendage lobes based on their divergent ontogenetic origins. The lobe closest to the fertile anther is referred to here as the auricle and the lobe beneath the auricle is referred to here as the staminode. Cell and tissue terminology in these lobes follows Fahn (1979).

Observing and processing tissues. In 2016, it was observed whether column appendages secreted droplets in *Corunastylis filiformis, C. fimbriata* and *C. ruppii* exposed to the air and protected under organza bags. To preserve specimens for lab microscopy, whole inflorescences were fixed in 3:1 95% ethanol:glacial acetic acid for 2–6 hours, then decanted and preserved

in 70% ethanol. This treatment keeps floral organs flexible but also clears pigmentation to observe tissue layers, locate specific cells and count vascular strands. Whole column appendages were excised from their columns, mounted on glass slides with distilled water for light microscopy, or with decolourised aniline blue for epifluorescence (*see* Goldblatt & Bernhardt 1990). Cleared specimens were viewed and photographed either under a Zeiss Axioskop 40 (*see* Edens-Meier *et al.* 2010) or a Zeiss Axio Imager M2. We looked for the presence of raphides in specimens mounted in distilled water. When raphide cells are clustered in orchid organs they indicate sites of slime or mucilage production (Smith 1923) and floral secretions (Bogarin *et al.* 2018). As nectar sugars are often supplied by phloem, we mounted specimens in decolorised aniline blue (Fahn 1979; Croy 1993) contrasting specimens under both polarised light and epifluorescence to locate callose in sieve cells.

Scent collection and analyses

Floral scents of *Corunastylis filiformis, C. fimbriata* and *C. ruppii* were collected *in situ* as described by Edens-Meier *et al.* (2014). Four inflorescences of each species were selected at random. Each inflorescence had 4–12 open flowers, and diurnal scent collection was performed on plants at the Bloodwood Road, Kulnura and Ku-ring-gai Chase sites. A headspace bag (Reynolds® Oven Bag; Reynolds, Inc., Richmond, VA, USA) was cut to dimensions of 10 × 10 cm and was used to cover each inflorescence. The bag was sealed at the bottom using a twist tie. An adsorbent trap, prepared using a Pasteur pipette with 10 mg Porapak Q (80/100 mesh; SUPELCO, Bellefonte, PA, USA) packed between glass wool, was attached to a battery-operated PAS-500 vacuum pump (Spectrex, Inc.) with Tygon tubing. The terminus of the trap was then sealed within the top of the headspace bag with a second twist tie. Floral scent was collected for two hours in the morning from 09:00–11:00, avoiding full sun, from January to April 2016 at a standardised flow rate of 200 mL air/min. At each of the three sites ambient air controls were also taken to account for, and to later eliminate, non-floral compounds. Upon completion of the fragrance collection, scent traps were eluted into 1.5 mL borosilicate glass auto-sampler vials using 300 µl of GC-MS grade hexane. Each vial was capped, labelled, wrapped with parafilm, and stored at -20°C. All collected sample vials were sent to the Kunming Institute of Botany, Chinese Academy of Sciences for GC-MS analyses.

Floral headspace samples eluted in hexane were concentrated to 50 µl under a flow of nitrogen gas (N_2). An internal standard of 5 µl of a 0.03% solution of toluene (23.6 ng) in hexane was added to each sample. The volatiles were analysed on a Hewlett-Packard HP 6890 Series GC System coupled to a Hewlett Packard 5973 Mass Selective Detector. An HP-5MS column (5% phenyl-methylpolysiloxane, 30 m long with an inner diameter of 0.25 mm and a film thickness of 0.25 µm; Agilent, USA) was used for analyses. Each 1 µl sample was injected at 240°C. Electronic flow control was used to maintain a constant helium gas flow of 1.0 mL/min. The GC oven temperature began at 40°C and increased 3°C per min to 80°C, then increased 5°C per min to 280°C and was held for 20 minutes. The MS interface was 250°C. The ion trap worked at 230°C. The mass spectra were taken at 70 eV (in EI mode) with a scanning speed of one per scan from m/z 35 to 500. Component identification was carried out using NIST 05 mass spectral database, and Wiley 7n.1.

Results

Floral phenology and floral development

As predicted, species were found in bloom during the austral summer (*Corunastylis filiformis, C. rufa, C. fimbriata* and *C. ruppii*) and/or from late summer until early April (*C. archeri, C. ciliata* and *C. morrisii*). The number of flowers per inflorescence appears to vary at interspecific and intraspecific levels (Table 1). *Corunastylis filiformis, C. fimbriata* and *C. ruppii* were more likely to produce >11 flowers/scape. The maximum number of flowers counted on a scape (n=34) was recorded in one specimen of *C. fimbriata* at the Ku-ring-gai Chase National Park site. Flowering patterns were sub-acropetal to asynchronous in all species. As the population of *C. ciliata* was fruiting when it was observed, it was not possible to observe its mode of floral development. In peduncles producing a mean of >11 flowers/scape, inflorescences showed open development with flowers becoming increasingly small towards the scape apices as in *Prasophyllum* (*see* Bernhardt & Rowe 1993). The terminal flower buds did not open in *C. filiformis, C. fimbriata* and *C. ruppii.*

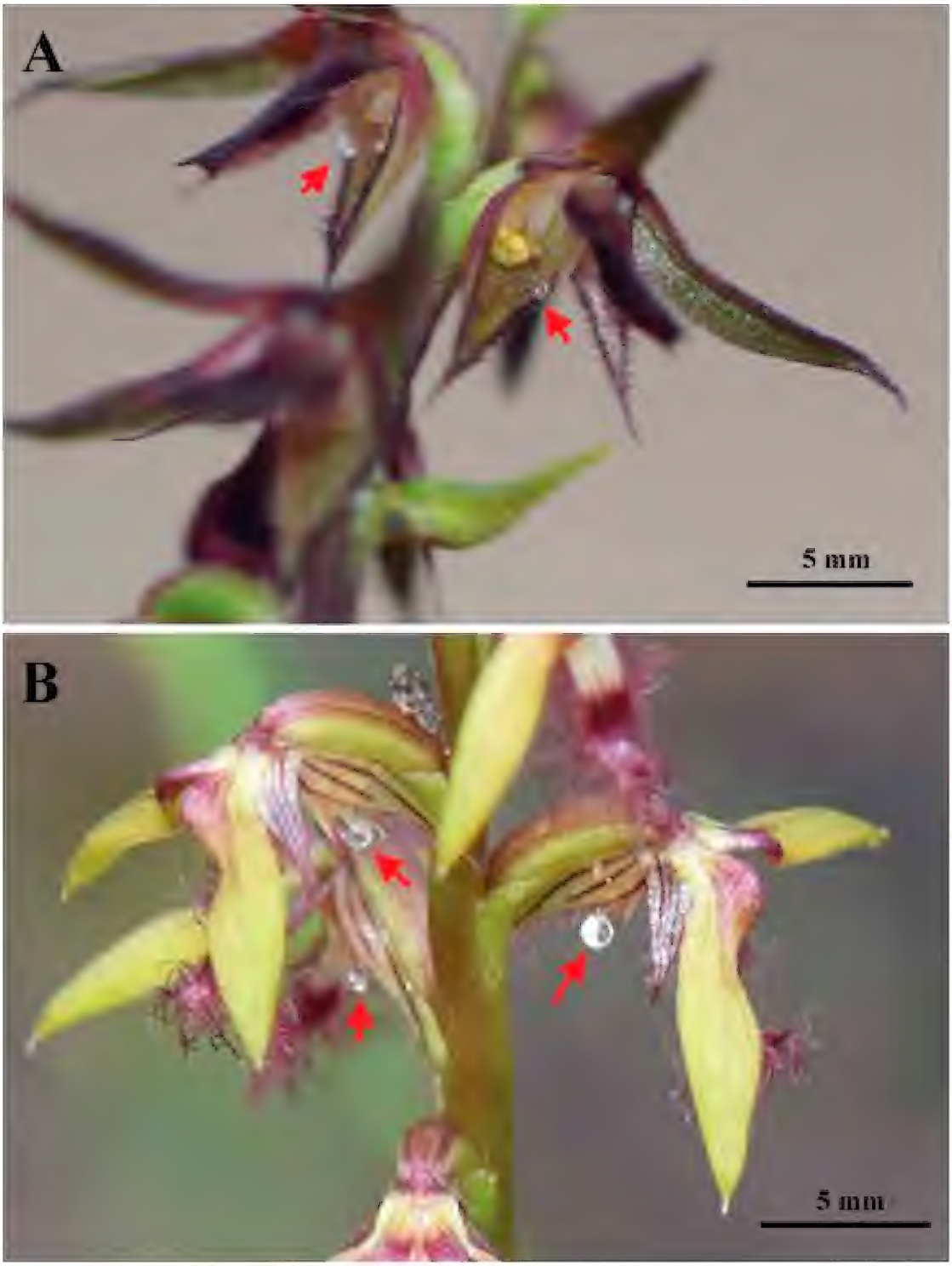

Figure 1. Secretion of auricles in *C. filiformis* (A) by B. Towle, and *C. fimbriata* (B) by Zong-Xin Ren.

Table 1. Comparative number of flowers/inflorescence (all sites pooled) and flowering periods (2016, 2017).

Taxon	n	Mean (S.D.)	Range	Flowering months (2016, 2017)
C. archeri	26	5.6 (2.4)	2-12	Mar.–Apr.
C. archeri × *C. ciliata*	11	4.8 (2.3)	2-9	Mar.–Apr.
C. ciliata	67	6.2 (2.9)	2-14	Mar.
C. filiformis	53	12.9 (4.5)	6-22	Jan.–Mar.
C. fimbriata	86	15.3 (5.3)	7-34	Dec.–Feb.
C. morrisii	7	5.6 (4.4)	3-15	Mar.
C. ruppii	63	14.6 (6.0)	5-32	Jan.–Mar.

One Heathcote specimen of *C. filiformis* (collected 04/03/2017) produced seven, terminal, unopened buds.

Labellum movement and secretions

All species and the putative hybrid had movable, hinged labella. The labella of four species trembled with passing air currents (Table 2). The movement of *Corunastylis fimbriata* was recorded (*see* https://perma.cc/4FWF-548B and view live page). Two species were found not to tremble in passing air currents (Table 2) and this lack of movement *in situ* is recorded for *C. ruppii* (*see* https://perma.cc/M5VU-WVNR). However, the labella of both species did vibrate or tremble when the scape was tapped gently with a probe at field sites, or, when fresh flowers still attached to severed scapes were probed under a dissecting microscope (Table 2).

We did not find droplets at the bases of the labellum callus in *Corunastylis filiformis*, *C. fimbriata* or *C. ruppii* in bagged or open flowers. Additional observations and macrophotography in February and March 2020 by R. Kuiter (pers. comm.) showed nectar at the bases of the callus plates of *C. archeri*, *C. ciliata* and *C. morrisii* in Victoria, similar to descriptions by Garnet (1940).

Column appendage secretions

Secretions were not detected on any of the staminode lobes in any species. Droplets were first observed on the auricles in unbagged flowers of *Corunastylis filiformis* (Figure 1A) and *C. fimbriata* (Figure 1B) respectively in 2015 and 2016. Removal of the viscous fluid with microcapillary tubes showed that auricles of *C. fimbriata* produced less than 1 µl of fluid. No sweet taste was detected in secretions of *C. fimbriata* or *C. filiformis*. Bagged flowers of *C. ruppii* at Ku-ring-gai Chase National Park, did not produce visible droplets but a small quantity of viscous liquid was found on shiny auricles under 40× magnification under a binocular dissecting microscope. This fluid attached to a probe or dried to a crust on the auricle. A chloropid fly with a dorsal deposition of one pollinarium was seen and photographed as it regurgitated a droplet of fluid while perched on an opening flower of *C. fimbriata* at the Bloodwood Road site on 26/01/2016 (Figure 2). As the four remaining taxa were not bagged as part of this study, we are unable to confirm column appendage secretions in them.

Floral epidermis and gross cytology of column appendages

Each column appendage in each species contained one vascular trace under epifluorescence (Figure 3A). The trace is median to the point where the staminode

Figure 2. Female *Conioscinella* sp. (Chloropidae) regurgitating fluid while carrying a pollinarium on an opening flower bud of *C. fimbriata* by Zong-Xin Ren.

Table 2. Raphides and labellum movement in *Corunastylis* taxa.

Taxon	Range of raphides in auricles	Raphides in staminodes	Labellum trembles
C. archeri	4–16	-	+
C. archeri × *C. ciliata*	1–10	-	NA
C. filiformis	9–42	+ -	+
C. fimbriata	1–9	+ -	+
C. morrisii	0–15	-	+
C. rufa	0–11	-	-
C. ruppii	6–23	-	-

is fused to the auricle, but it does not penetrate the apices of either of the lobes. In all species, staminodia are ornamented with elongated, unicellular trichomes, as compared to the almost glabrous auricles (Figure 3A). In *Corunastylis morrisii* and *C. rufa* the staminodia are longer than the auricles. In the remaining species, and the putative hybrid, the auricles are equal or sub-equal to the length of the staminodia (Figs. 3B–D). The apices of the auricle lobes of all species consisted of one to three tiers of large, overlapping cells containing granular cytoplasm. The marginal apex of the auricle of *C. archeri* (Figure 3A) and its hybrid, *C. archeri* × *C. ciliata*, is notched or a shallow bowl. The elongated auricle of *C. fimbriata* has a pore or depression at its apex (Figure 3B). The length of auricles and column appendages varied between inflorescences in the same species (Figures 3C and 3D).

Raphides were usually confined to the auricle lobes (Table 2, Figure 3C) but the numbers of raphides in each auricle varied between species, between members of the same species (Figure 3 C, D) and between flowers on the same inflorescence. Some staminode lobes in *Corunastylis fimbriata* contained a maximum of nine raphides in the auricles and 0–4 in the staminode lobe of the same column appendage (Table 2). In *C. fimbriata* and *C. filiformis*, raphides may be so congested at auricle apices that they overlap, are difficult to count and may turn the auricle apex black or brown as it dehydrates with age (Figure 3B–D). Observations of auricles from *C. filiformis* collected at Heathcote National Park retained 2–17 raphides (n=5 inflorescences) at their apices (Figures 3C and 3D). In the auricle of a single specimen of *C. filiformis* there was a maximum of 42 raphides with 14 raphides congested at the auricle apex and an additional four in the staminode lobe.

Scent production and analysis

A lemony scent reminiscent of commercial extracts of rhizomes of *Cymbopogon citratus* (DC.) Stapf. was detected from fresh flowers of *Corunastylis fimbriata*, as described in the literature. However, on 15/01/16, three inflorescences of this species were placed into a clean, capped jar for 30 minutes. The accumulated odour was unpleasant, with a note reminiscent of a chlorinated swimming pool but dominated by "butcher shop smells" associated with oxidising fat on commercial cuts of lamb or beef. It was not possible to discern fragrances in the two remaining species even when they were placed in clean, capped jars. Scent analyses of *C. filiformis*, *C. fimbriata* and *C. ruppii* are based on retention times of 22.03–38.28 minutes. *Corunastylis ruppii* produced the greatest number of identifiable compounds. A total of 7 peaks recorded from 22.03–24.64 were found for *C. fimbriata*, but the long storage period (3 months) made it possible to identify only nepetalactone. Flowers of *C. ruppii* produced the greatest number of identifiable compounds (n=5) and we note that both *C. ruppii* and *C. filiformis* share 8-heptadecene, though at very different relative abundance (Table 3).

Discussion

General floral presentation

The number of flowers produced by a raceme may vary between some *Corunastylis* species, with scapes of *C. fimbriata* producing the greatest number of flowers in 2016. While the labella of all *Corunastylis* species do not tremble in the wind, the labella of *C. rufa* and *C. ruppii* move under slight physical pressure.

Our observations of floral secretion and analyses of column appendage morphology strongly suggest

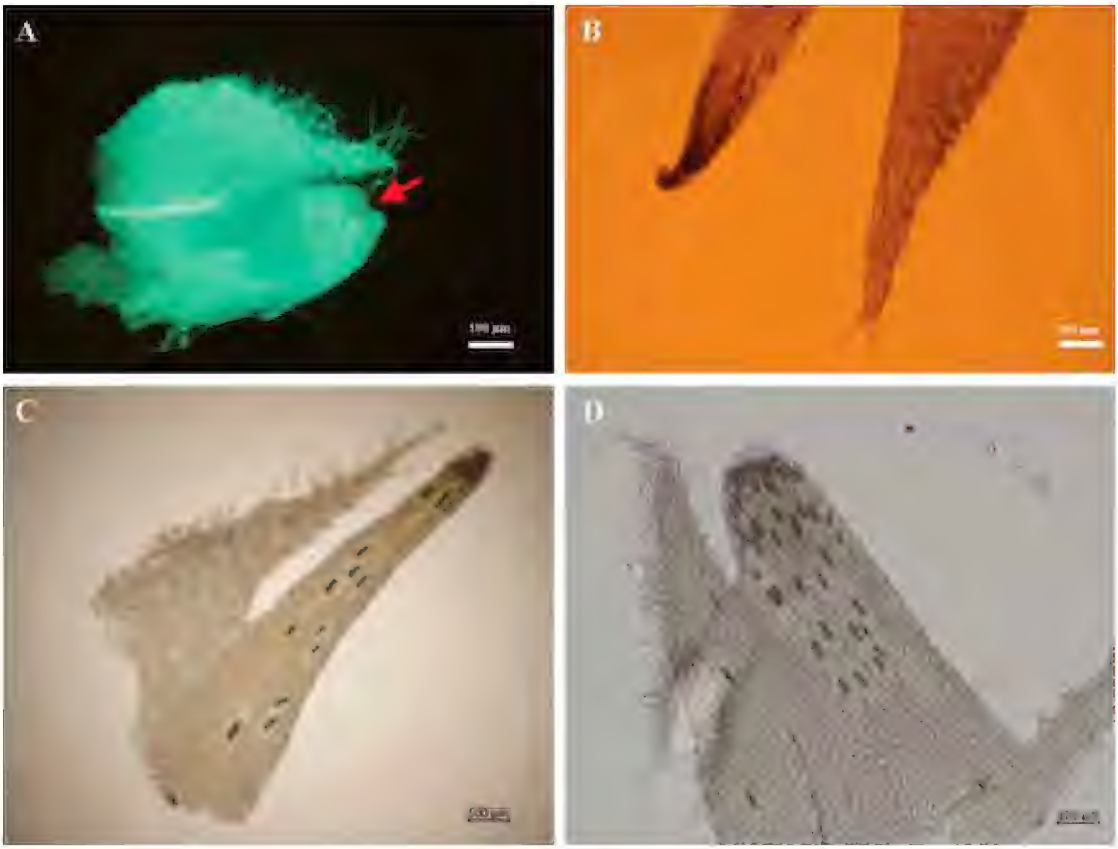

Figure 3. Column appendages of *Corunastylis* species. (A) Column wing of *C. archeri* showing the hairy staminodium lobe and the glabrous but notched auricle lobe (arrow). Note the phloem trace combining epifluorescence and polarized light by Qi Qiao; (B) Ageing column wing of *C. fimbriata* with dark, overlapping and congested raphides at apex in the elongated auricle and absence of raphides in the hairy staminode by Qi Qiao; (C) Raphides in the auricle and staminode lobes of *C. filiformis* (Heathcote National Park) by Peter Bernhardt; (D) Raphides in the auricle lobes of *C. filiformis* from a different flower from the same population (Heathcote National Park) by Peter Bernhardt. Note differences in length of the auricle lobes and distribution of raphides.

Table 3. Scent analyses of three *Corunastylis* species.

Molecule	**Highest relative abundance (%) recorded**		
	C. filiformis	*C. fimbriata*	*C. ruppii*
Dodecen-1-ol	-	-	1.21
8-heptadecene	24.17	-	73.06
4-hydroxy-2-methylacetophenone	-	-	9.23
(4-isopropylphenyl)-methanol	-	-	9.05
Nepetalactone	-	9.92	-
Tridecane	-	-	59.02

that the auricles, not the staminode lobes, offer a liquid reward to pollinators in three *Corunastylis* species. It is therefore suggested that, within the genus *Corunastylis*, there may be more than one secretory site in the flowers. Different feeding locations may, in turn, facilitate divergent foraging behaviors of pollinators leading to either head or thorax deposition of pollinaria (Kuiter 2018). Garnet (1940) observed chloropids feeding on labellum nectar in *C. archeri* and *C. nigricans*. He concluded that, while the self-inverted fly foraged for nectar at the base of the labellum callus, the weight of the insect caused the jointed labellum to collapse onto the column. This collision transferred the viscidium to the dorsum of the fly's thorax, releasing the stipe and its attached pollinia. There is now a second option based on our location of a second reward site. The labellum may also tilt into the receptive column while the insect attempts to forage on auricle secretions.

Comparative presentation of column appendages in three *Corunastylis* species *versus* other orchids

Burns-Balogh & Bernhardt (1985) proposed that the column appendages and/or staminodia of some lineages in Orchidaceae were often functional and should not always be dismissed as vestigial organs. The most obvious example within Diurideae is found in large-flowered species in the genus *Thelymitra*. Each pair of staminodes in the same flower is usually connate, forming an ornamented hood attracting foragers that ultimately contact the viscidium and receptive stigma lobes (*see* Edens-Meier & Bernhardt 2014). Excluding the wet stigma lobes, the secretion of fluids by column organs remains rare in Orchidaceae. The most often cited example is in the epidendroid genus, *Coryanthes* (Stanhopeinae). A pair of glands, known as pleuridia, flank the base of the column. Pleuridia may actually represent the extended and much modified bases of the column appendages, adnate to the lower style (Gerlach 2011). These glands secrete a watery slime into the bucket-like lamina of the labellum. The only known pollinators are male euglossine bees that fall into the bucket as part of the pollinarium dispersal process. The accumulated liquid lacks edible rewards and appears to slow bee escape (Roubik 2014).

The auricles of all *Corunastylis* species examined contained clusters of raphides. In orchids, raphides produce mucilage (Smith 1923). Raphide clusters in the auricles of *C. filformis, C. fimbriata* and *C. ruppii* might produce dilute mucilage, contributing to a diluted or viscous (e.g. *C. ruppii*) reward. It was not possible to observe auricle secretions in the remaining three species, and Garnet (1940) showed previously that the same species produce nectar at the bases of their labellum calluses. It was noted that the auricle of *C. archeri* is so reduced in size, compared to the auricles of *C. filiformis, C. fimbriata* and *C. ruppii*, that it could be interpreted as a vestigial organ. However, as all auricles of all species studied contain raphide clusters, it could be that these cells no longer contribute to the pollination mechanism in some *Corunastylis* species. Perhaps raphide clusters in auricles of some *Corunastylis* species have additional functions, as they do in the floral organs of some Neotropical orchids also pollinated by micro-dipterans. For example, they could play a role in the synthesis of trace nutrients or scents as suggested for *Trichosalpinx* species (Bogarin *et al.* 2018). Their presence could also present a refractile visual cue that helps attract and orientate pollinators, as proposed for *Stelis* aff. *purpurescens* A. Rich. & Galeotti (Chase & Peacor 1987). Specifically, raphides in *Corunastylis* species could make the auricles appear shinier and more attractive to incoming chloropids as they are present in such a thin matrix of tissue.

It was also noted that secretory column appendages remain unreported in the allied genus *Prasophyllum* (as *Chiloterus*, *Mecopodum* and *Prasophyllum s.s* in Jones 2006). These taxa are more likely to be pollinated by larger bees, wasps and syrphid flies (Weston *et al.* 2014). Floral structures in this genus also lack the trembling labellum (Jones 2006). Nicholls (1969) completed descriptions and detailed iconographies of many *Prasophyllum* species. Examination of his plates and descriptions of 44 species show glabrous to sub-glabrous staminodia and much-reduced auricle lobes. A few species show auricles with a wrinkled to lumpy epidermis (e.g. *Prasophyllum flavum* R.Br.). Nicholls also wrote that the column appendages of many of these species were "inconspicuously bilobed" or that the column appendage was "short lobed" at its base.

Specialised floral scents

The molecule identified as 8-heptadecene appeared to dominate the scent of *Corunastylis filiformis* (70.1–73.06%) but was found in only 3 out of 4 inflorescences of *C. ruppii* (4.89–24.17%). The presence of tridecane (11.90–30.32%) in *C. ruppii* is of particular interest as it may attract *Conioscinella* species (Chloropidae) to flowers in the genus *Ceropegia* (Apocynaceae) according to Heiduk *et al.* (2017). Kaiser (2011) detected this molecule in the floral scents of more than 35 species in seven families of monocots, eudicots and as a trace in the eumagnoliid, *Magnolia delavayi* Franch. This included 19 orchid species representing three subfamilies (Cypripedioideae, Orchidoideae, Epidendroideae), but in far lower proportions (0.03–3.0%) compared to *C. ruppii*. The loss of scents in our collections of *C. fimbriata* due to long-term storage was unfortunate as six additional compounds were present but too low in volume to identify (unpublished). The lemony odor of its fresh flowers would suggest citronellal or citronellol (R. Raguso, pers. comm.). The presence of nepetalactone in *C. fimbriata* is novel as it was first isolated in stems and leaves of catnip (*Nepeta cataria* L. (Lamiaceae)). This molecule does attract cats (McElvain *et al.* 1941) but commercial concentrations are also reputed to repel some mosquitos (*Aedes* spp. (Culicidae); *see* Kingsley 2001).

Interpreting the suite of floral traits

Based on the evidence presented, there are now two possible interpretations of floral presentation in *Corunastylis filiformis, C. fimbriata* and *C. ruppii*. These two interpretations may, in fact, overlap. First, the high proportion of tridecane in *C. ruppii* allies with past work showing that female chloropids are attracted to wounded heteropterans (Zhang & Aldrich 2004). Dodecen-1-ol and 8-heptadecene, derived from *C. ruppii*, are similar in structure to the long chain hydrocarbons and carboxylic acids (*see* Bogarin *et al.* 2018) identified in *Trichosalpinx* species, pollinated by blood drinking females in the Ceratopogidae. In this case, the viscous or sticky exudate of the auricles of *C. ruppii* may simulate haemolymph and would help explain the comparative absence of labellum movement unless it is probed. Bower *et al.* (2015) were the first to propose this model in *Corunastylis littoralis* without a scent analysis.

Second, in Australia, chloropids are commonly referred to as eye gnats or eye flies as the winged adults are known to feed on lachrymal secretions as they move from orifice to face (Matheson 1950) and may be trapped using a range of scents (Rogoff *et al.* 1973; Heiduck *et al.* 2017). It is suggested here that the floral secretions, combined with the hairy, darkly pigmented labella and staminodes of some *Corunastylis* species, may mimic the respective tears and eyelids of mammals. Borba & Semir (1998) suggested that wind was necessary to effect pollinarium transfer in *Bulbophyllum ipanemense* Hoehne as the weight of the tiny fly was insufficient to tilt the labellum towards the column. While the authors agree that the hinged, cantilevered labellum in *C. filiformis and C. fimbriata* may also operate under a wind-facilitated system, a second function should also be considered for the same modified petals. Specifically, a fluttering and hairy labellum is mimetic and helps to attract those micro-dipterans that are the primary dispersers of pollinaria. Of course, this new interpretation is ultimately dependent on future chemical analyses of auricle secretions. If signature salts and amino acids are identified in these secretions, it is reasonable to suggest that these flowers are winking at their prospective pollinators!

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ROYAL BOTANIC GARDENS VICTORIA

The flora of James Cook's 'Botany Isle' (Îlot Améré) and the neighbouring islets of Kié and Nouaré (New Caledonia): revisited and re-evaluated after nearly 250 years

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Introduction

In advance of the approaching 250th anniversary of the discovery of New Caledonia by Europeans during James Cook's famous 2nd voyage (1772–1775) towards the South Pole and around the world (Cook 1779), it was deemed appropriate to revive the memory and records of one of the two sites where he went ashore within the archipelago, with a reviewed account of its botany.

Commander James Cook (1728–1779) left Plymouth, England, on 13 July 1772 aboard HMS *Resolution* for his second voyage commissioned by the British government in search of the hypothesised southern continent. The German Johann Reinhold Forster (1729–1798) and his son Georg Forster (1754–1794) were appointed as the Royal Society scientists for the voyage. Georg Forster was just 17 years old when he embarked on the ship but was already a talented draughtsman and translator. Later he became one of the most famous German characters of the 18th century, as a naturalist, taxonomist, ethnographer, writer, and even revolutionist introducing the ideals of the French Revolution to the German community (Harpprecht 1990). The Forsters were accompanied by the Scotsman William Anderson (1750–1778), surgeon of the ship

Abstract

When James Cook visited New Caledonia in 1774, one of the localities inspected was 'Botany Isle'. Cook's and Wales's journals are used to ascertain the position of Botany Isle and draw new maps. Crew members landing on Botany Isle (including scientists Johann Forster and Georg Forster) reported seeing about 30 plant species, yet only 7–15 species were documented, either with herbarium specimens or in subsequent literature. Based on our botanical inventory of Améré, Kié and Nouaré islets, the species that may or may not have seen by the Forsters on their 'Botany Island' are discussed, raising nomenclatural questions. A comprehensive list of species found on these islets is provided and conservation issues discussed.

Keywords: Botanical inventory, historical herbarium specimens, Îlot Améré, maps, Yves Merlet Integral Natural Reserve.

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but also an observant naturalist and collector. Anders Sparrman (1748–1820), a Swedish apostle of Linnaeus, embarked on the *Resolution* on 30 October 1772 in Cape Town (South Africa), and left the ship there again in July 1775. He was appointed as assistant naturalist to the Forsters. Finally, William Wales (1734–1798) was the astronomer for the voyage.

More than two years after its departure, and having just visited Vanuatu, the *Resolution* arrived, on 4 September 1774, in sight of a land new to the British and Europeans, later named New Caledonia by Cook. Following a stay of about one week at the north-east end of Grande Terre, now known as Balade, the ship went south-east along the coast, passed Cape Coronation and Queen Charlotte's Foreland, and sailed around the Isle of Pines in order to explore the western coast of Grande Terre. In doing so, Cook soon understood that they were trapped in a kind of dead-end, surrounded by reefs and small sandy islands to the east, by the southern tip of Grande Terre to the north, and by the large, south reef horn (Corne sud) to the west. It was an opportunity to solve the now famous debate that had arisen a few days earlier between Cook and the Forsters about the pillar-like structures they had been seeing along the south-east coast of Grande Terre, on many islets and the Isle of Pines. In Cook's opinion, the pillar structures were some "singular sort of trees", while in the Forsters' opinion they were pillars of basalt like those of the Giant's Causeway in Ireland (Cook 1779: 133–134). On 29 September 1774, Cook was determined to close the debate and anchored about one mile from the west side of an islet in water about 70 metres (39 fathoms) deep. Cook and the botanists went ashore to solve the mystery and, on this flat, coral sand island of 5.6 ha, discovered that the pillars were indeed a kind of "spruce pine". This eye-catching species was later described as *Cupressus columnaris* G.Forst. by the younger Forster (Forster 1786a), now placed in the genus *Araucaria* Juss. as *Araucaria columnaris* (G.Forst.) Hook. This species was also later named in honour of Cook by subsequent botanists as *Araucaria cookii* R.Br. ex D.Don or *Eutacta cookii* Carrière, both now regarded as synonyms of *Araucaria columnaris*. Surprised by the variety of plants on such a small island, as well as by the fact that such big trees were growing on it, Cook named the islet 'Botany Isle' (or 'Botany Island' in Forster 1777).

In this paper, we aim to: i) ascertain whether Botany Isle is the present day Îlot Améré; ii) study the botany of Botany Isle at the time of Cook's visit on 29 September 1774 from a literature review perspective; iii) examine the specimens presumably collected on Botany Isle, and raise some nomenclatural questions; and iv) compare the historical data with those of a recent botanical inventory on Îlot Améré, as well as neighbouring Kié and Nouaré islets, carried out by three of the authors from 1 to 3 April 2019.

Material and methods

The available standard literature by and/or concerning Cook (Cook 1772–1775, 1777, 1779), Forster senior (Hoare 1982) and junior (G. Forster 1777, 1778, 1780, 1786a, 1786b), Sparrman (Pisier 1974; Wästberg 2008), Anderson (Beasley 2012) and Wales (Wales 1772–1775) was studied.

In order to validate the true position of Botany Isle and other places named by Cook, two manuscripts were used: Cook's own journal (Cook 1772–1775) and the navigation logbook compiled by Wales (1772–1775) from 21 September until the arrival at Botany Isle on 28 September. It should be noted that Cook's journal follows a regular calendar, whereas Wales' navigation log gives astronomical days and hours, in which a day begins at noon. Consequently, the arrival at Botany Isle is recorded by Cook as the end of the morning of 29 September, while it is recorded by Wales as 22h on 28 September. The dates and hours indicated in Figure 1 follow the astronomical calendar. Given the lower accuracy methods used to determine latitude and longitude at that time, a decision was made to use bearings from the 32-wind compass rather than the coordinates given by both documents and the Cook map (Cook 1772–1775: 340–341). All bearings taken were reported on SHOM (2010) marine charts using QGIS 3.4 advanced digitising tools. Bearings with at least three references on land are considered accurate; others are only used to adjust trajectories. Further data from the texts were used to confirm the positions and trajectories obtained. As for unit conversion, we considered a fathom to be 1.8 m (1/1000 of a nautical mile) and a league to be 4.8 km (three miles on land).

Available herbarium specimens presumably collected on Botany Isle during Cook's landing (Global Plants

on JSTOR: https://plants.jstor.org/; Kew Herbarium Catalogue, http://apps.kew.org/herbcat/navigator.do; and other web sources) and literature dealing with these specimens (e.g. Merrill 1954a, 1954b; Hiepko 1969; Fosberg 1993; Hansen & Wagner 1998; Nicolson & Fosberg 2004) were checked extensively. We also studied specimens collected more recently on the islets under consideration that are held in NOU (herbarium codes follow Thiers 2020 [continuously updated]).

For comparison, a botanical inventory of Îlots Améré, Kié and Nouaré was conducted. Améré and Kié are part of the 'Yves Merlet Integral Natural Reserve' to which access, as well as the collection of specimens, is strictly forbidden. The South Province Direction de l'Environnement authority granted the authors special access to the reserve for this study and made available two boats (the *Améré* and *Noddi*). Inspections took place on Améré on 1 April, on Kié on 2 April and Nouaré on 3 April 2019. In order to limit the impact on the local flora and to comply with the special authorisation, the minimum number of specimens needed to identify plants at the species level were collected, but as many species as possible were recorded and photographed in the field, and their relative abundance rated from 1 to 3 (1=rare, 2=fairly common, 3=very common; Table 1). The specimens collected during the field trip are deposited in Nouméa (NOU), and the most significant collections also lodged as duplicates in Paris (P).

Results and Discussion

Is Îlot Améré the Botany Isle of Cook's journal?

Although Cook's Botany Isle has long been associated in the literature with present day Îlot Améré, it was deemed important to cross-check and verify this assertion. With the help of Cook's very detailed and accurate journal, and Wales's navigation logbook, we were able to confirm Botany Isle as Îlot Améré (Figures 1–2). Figure 1 shows all usable Wales bearings noted during the few days prior to the arrival at Botany Isle. In listing them, it was found that what is called Cape Coronation on most modern maps (e.g. Pisier 1971; Robson 2000; Georep 2020; IGN 2020) should, in fact, be called Queen Charlotte's Foreland, while the current Cape Pouaréti is a synonym of Cape Coronation. This confusion explains why Cook's bearings, setting the low and high points of Queen Charlotte's Foreland respectively at N14°30'W and N20°W (Figure 2), actually point to Cape Coronation on modern maps (Georep 2020; IGN 2020). The correction of this error eliminates the last uncertainty about the position of Botany Isle. This misleading error merits further research and explanation, as one of the earliest accurate maps of New Caledonia is correct in its placement of Cape Coronation and Queen Charlotte's Foreland (Malte-Brun 1874). The first occurrence of this error likely appeared in 1886, on an official map (Gallet 1886).

It was not possible to establish with certainty who first identified Îlot Améré as Cook's Botany Isle. However, as early as 1853, a footnote (Erskine 1853: 401) pointed out that the French Chart was erroneous in applying the name of 'Botany Islands' to two southern reef sandy islets (presumably the present day Îlot Du Ami and Îlot Dü-Ana or Îlot Ndié) that do not have any pines (i.e. *Araucaria*) and which are "not offering any field for botanists". As far as could be ascertained, the first use of the name might have been by Bouquet de la Grye in his mapping of New Caledonia between 1855 and 1857. Bouquet de la Grye (1858) wrote about 'Amere' as 'Botany-Island' and later (Bouquet de la Grye 1862) placed Îlot Améré quite accurately, setting Cook's anchorage place within the reefs on the east of Améré (instead of east by south *fide* Cook's journal). Based on Wales's writings, however, it was found that the anchorage was actually west of the islet ("we came to anchor under the lee of the proposed island which then bore N88°1/2E"), and this is confirmed by the subsequent bearings he made (Figure 2). This confirms the hypothesis of Pisier (1974), who wrote that Cook's comment that "the isle bore WbN, one mile distant" was probably a mistake. Furthermore, the other clues available regarding depth, wind, current and courses all converge on an anchorage on the lee (west) side of Botany Isle.

During our stay on Îlot Améré, attempts were made to find tools and/or signs of Cook's passage on the islet. A specimen of *Araucaria columnaris* that was cut and later resprouted was located (Figure 3b), but it is difficult to assert that it was actually one of the 8–9 spars (it is not said how tall the trees were) cut down by Cook's carpenters (John Marra in Pisier 1974) since *Araucaria* stumps are unlikely to persist for 245 years. A torpedo glass bottle (most likely used for soda) made by John Starkey in Sydney, 140 Phillip Street, was also found on

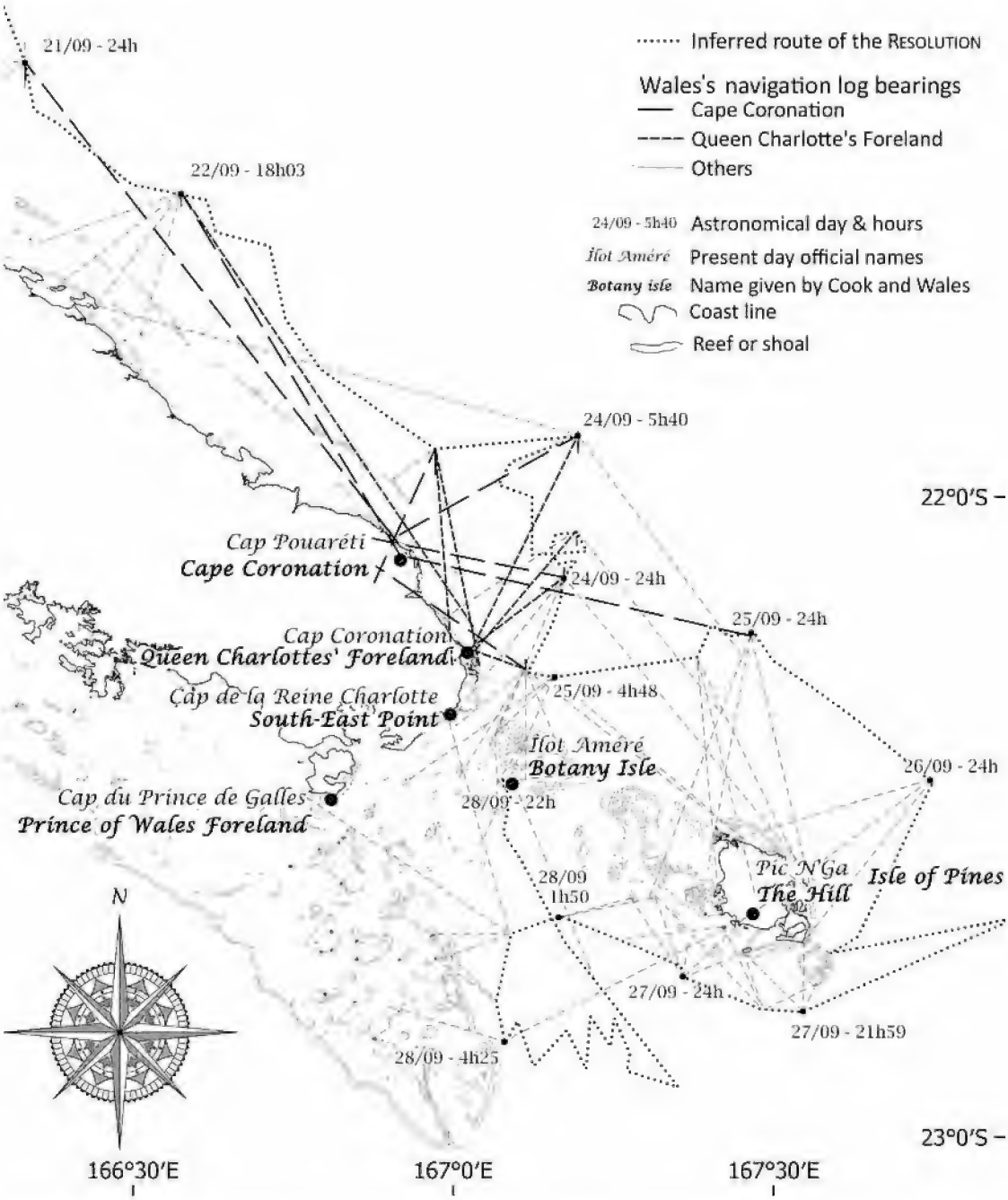

Figure 1: Map of the south of New Caledonia showing Cook's named localities (names in bold) and the H.M.S. *Resolution*'s route (dotted line) following Wales's bearings (dashed line). Present-day locality names from official maps are in normal font. Days and hours are given following the astronomical calendar. Black curved lines represent coast lines, and faded curved lines represent reefs or shoals. Map produced using GEOREP (2020).

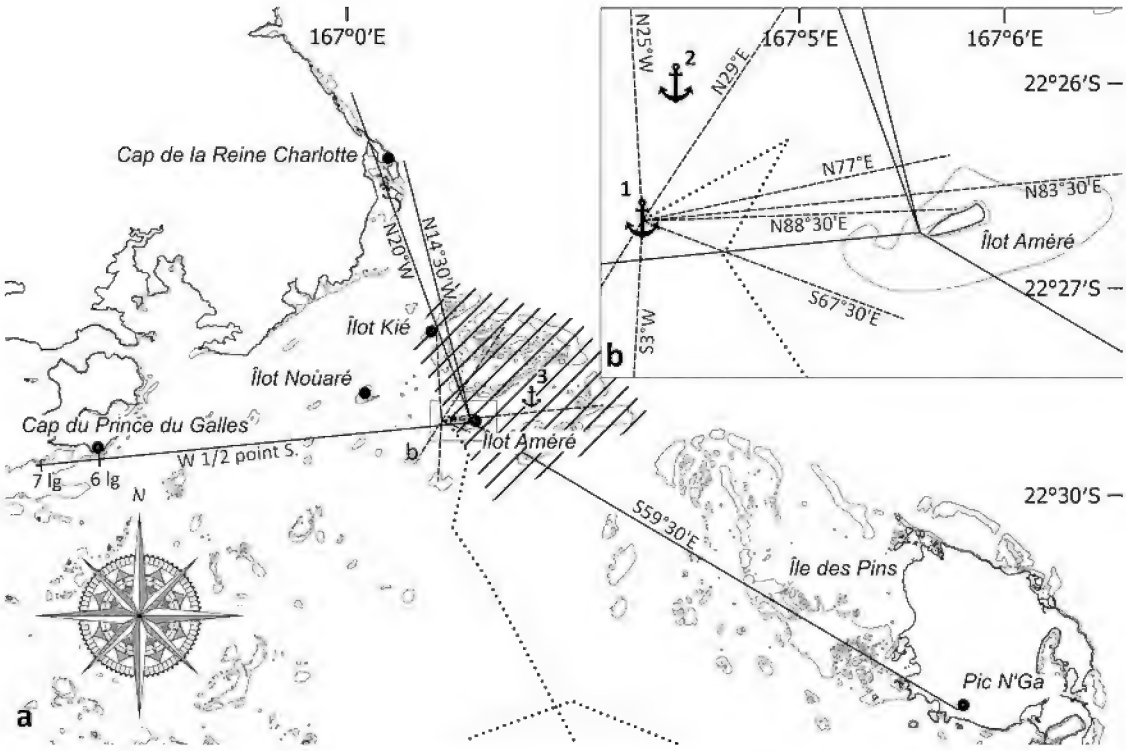

Figure 2: a. Map of the southern tip of New Caledonia's Grande Terre and Isle of Pines; b. Detailed map of Îlot Améré and its surrounding reefs. Cook (1772–1775) bearings (plain line) made on Botany Isle, Wales (1772–1775) bearings (dashed line) made from the *Resolution* at anchorage and the putative arrival route to Botany Isle (dotted line). Anchors represent (1) our inferred position of the anchorage, (2) Pisier (1974) and Robson's (2000) inferred position, and (3) Améré anchorage on Bouquet de la Grye (1862) and Cook anchorage on Laporte (1903) maps. Azimuth given are those found in the manuscripts, lg = leagues. Locality names are the present day French names, with Cap de la Reine Charlotte placed at its correct position following our deductions. Hatched area represent the Yves Merlet Integral Natural Reserve.

Îlot Améré (Figure 3c). It was probably produced around 1860–1870, and presumably abandoned on Îlot Améré by Australian sandalwood traders that were active during this period (Shineberg 1967; Guillaumin 1970).

The Botany Isle from the original literature

Under the journal entry for Thursday 29 September 1774, Cook (1779: 139) described Botany Isle with these words: "The little isle upon which we landed, is a mere sand-bank, not exceeding three–fourths of a mile in circuit ("not more than two miles in circuit" acc. Forster 1777). On it were several water-snakes [Elapideae; *Hydrophis* (*Anguis*) *platurus* acc. Forster (1777); *Laticauda* sp. [most likely] according to Wales (1772–1775), who reported "snakes with skins … in rings, alternately black and white…"], some pigeons and doves. One of the officers shot a hawk … of the very same sort as our English fishing-hawks". Two hundred and forty-five years after Cook´s records, it was possible to make the same observations, as sea-snakes (Elapidae: *Laticauda saintgironsi*) were seen, along with sightings and the frequent calls of fishing-hawks (Western Osprey, *Pandion haliaetus* subsp. *melvillensis*; Figure 3a). However, pigeons were not observed rather, the island was highly populated by breeding *Ardenna* (Wedge-tailed shearwater; Figure 3f), and honeyeaters were also seen (Figure 3d). With regard to human presence, Cook also reported that "Several fire places … showed that people had lately been on the isle", and "The hull of a canoe … lay wrecked in the sand". Thus Cook and the Forsters were not the first human beings to set foot on this little piece of land. As a matter of fact, some local Kanak people from Touaourou (Queen Charlotte's Foreland area) went to Îlot Améré immediately after

Cook's departure and observed the crew had cut some trees and lit a fire in a manner different to their own (Bouquet de la Grye 1858). The Kounié (inhabitants of Isle of Pines) also used to go to Îlot Améré to hunt turtles (Pisier 1969). With regard to botany, Cook´s interest while staying on Botany Isle was focused on *Araucaria* trees – the carpenters of the *Resolution* took the opportunity to cut trunks as perfect material for the substitution of spars. However, Cook (1779: 139–140) also wrote the following three sentences: "besides these pines, grew the Etos tree of Otaheite and a variety of other trees, shrubs and plants […] besides these, there was another tree or shrub of the spruce fir kind, but it was very small […] We also found on the isle a sort of scurvy-grass, and a plant, called by us Lamb's Quarters, which, when boiled eat like spinage". The *Etos* tree of Otaheite might refer to the common coastal ironwood *Casuarina equisetifolia* L. (Figure 3d). The other tree or shrub reminiscent of a "spruce fir" most probably refers to young heterophyllous *Araucaria columnaris* as no other *Araucaria*, or indeed any other gymnosperm, grows on such islets. In English, scurvy-grass usually refers to species of the genus *Cochlearia* L. (Brassicaceae). During our survey, two species of Brassicaceae were found on the islets, *Cakile maritima* Scop. (Kié and Nouaré) and *Lepidium bidentatum* Montin (Améré, Kié and Nouaré); see Table 1 and Figure 3k). The *Lepidium* species is similar in appearance to *Cochlearia officinalis* L. and is most probably the one Cook referred to, but a species of Nyctaginaceae, *Boerhavia acutifolia* (Choisy) J.W.Moore, cannot be ruled out as it might also be confused with *Cochlearia* by a non-botanist. In Europe, the so-called 'Lamb's Quarters spinage' usually refers to *Chenopodium album* L. (Amaranthaceae). During our survey within the islets (Table 1), two taxa of Amaranthaceae were found: *Achyranthes aspera* L. and *Salsola* aff. *australis* R.Br. (usually found and known under the name *Salsola kali* L. in New Caledonia, e.g. Munzinger *et al*. 2020). However, other indigenous Amaranthaceae species can be seen in such sandy islets in New Caledonia, for

Figure 3: a. Upper third of *Araucaria columnaris* tree with Western Osprey (*Pandion haliaetus* subsp. *melvillensis*) sitting on top; b. *Araucaria columnaris* stump; c. Ancient torpedo glass bottle (manufactured by J. Starkey, Sydney) found on Îlot Améré by E. Herlem on 1 April 2019; d. Grey-eared honeyeater (*Lichmera incana* subsp. *incana*) with unusual feeding behaviour on honeydew from mealybug on *Casuarina equisetifolia* (Cook's "Etos tree of Otaheite"); e. Yellow-lipped sea krait (*Laticauda saintgironsi*) coming to the beach; f. Juvenile of Wedge-tailed shearwater (*Ardenna pacifica*) at entrance of its burrow.

example *Atriplex jubata* S.Moore, *Enchylaena tomentosa* R.Br. and, to a lesser extent, *Chenopodium nutans* (R.Br.) S.Fuentes & Borsch, *Salicornia quinqueflora* Bunge ex Ung.-Sternb. and *Suaeda maritima* (L.) Dumort. Other tasty, spinach-like plants found on the three islets are the Aizoaceae species *Tetragonia tetragonoides* (Pall.) Kuntze (Figure 3l) and *Sesuvium portulacastrum* (L.) L. As *Salsola* aff. *australis* is spiny, it is our opinion that the most probable Lamb's Quarters plant *sensu* Cook was indeed *Tetragonia tetragonoides* (confirmed by J.R. and G. Forster and Sparrman texts) and less probably *Atriplex jubata* because the latter was not spotted on the three islets. It is also important to note that the taxonomy and/or the names used for Amaranthaceae in New Caledonia require broad revision in a wider Pacific context as the names cited above might not be the correct ones.

From G. Forster's journal (1777), not much more can be learnt than what was reported in Cook's journal (1772–1775). The most interesting parts dealing with the flora of Botany Island are the following: "The tall trees immediately demanded our first attention, and we found that they belonged to the genus of cypresses [...] A variety of other trees and shrubs grew up between them [...] We saw here also some scurvy-grass, and another plant (*tetragonia*), which we commonly made use of at New Zeeland in our soups [...] We met with a variety of plants in the afternoon, which quite surprised us, on such a confined spot [...] Captain Cook gave this little islet the name of Botany Island, because it contained in so small a space a flora of near thirty species, among which we saw several new ones". From Hoare (1982), J.R. Forster's journal reads, "we saw several new plants

Figure 3 (continued): g. *Dicliptera caerulea*; h. *Suriana maritima* (section of Forster´s Skizzenbuch drawing no. 39, s. text); i. *Suriana maritima*; j. *Nicotiana forsteri*; k. *Lepidium bidentatum* (Cook and Forsters'"scurvy-grass"); l. *Tetragonia tetragonioides* ('Lamb´s Quarters' sensu Cook; eaten as spinach, s. text); m. *Wollastonia lifuana*. [a–e, g, j–k: Améré, 1 April 2019; f, i: Kié, 2 April 2019; l, m: Nouaré, 3 April 2019. [Photos: a, j, U. Meve; b, d–f, k, G. Gâteblé; c, C. Geoffray; g, i, l, m, S. Liede-Schumann].

Figure 4. Views of Améré, Kié and Nouaré islets. a. Îlot Améré as seen from the *Améré* boat looking from the north with few *Araucaria* on its east side; b. Îlot Améré south-eastern beach, view east with the *Araucaria* stand; c. Îlot Kié as seen from the north-west, almost entirely covered with *Araucaria*; d. Îlot Nouaré as seen from the north without any *Araucaria*. [Photos: a–d: U. Meve]

& likewise the *Lepidium piscidium* & *Tetragonia oleracea* […] & the curious thing was at last found to be the Spruce fir-tree (a *Cypress ratheo* [*Araucaria columnaris*]) of a new kind". Georg Forster (1786a, 1786b) reported ten species as coming from Botany Island as 'Botanices Insula' or 'Botanicesque Insula'; the numbers refer to the ones used in Forster (1786a): *Dicliptera caerulea* (G.Forst.) Schinz & Guillaumin (as *Dianthera caerulea* G.Forst., 14), *Nicotiana forsteri* Roem. & Schult. (as *Nicotiana fruticosa*?, 104), *Cynanchum viminale* subsp. *brunonianum* (Wight & Arn.) Meve & Liede (as *Cynanchum viminale* (L.) L., 127), *Salsola* aff. *australis* R.Br. (as *Salsola kali*, 130), *Haloragis prostrata* J.R.Forst. & G.Forst. (as *H. prostrata*, 179), *Suriana maritima* L. (as *S. maritima*, 199), *Myoporum crassifolium* G.Forst. (as *M. crassifolium*, 240), *Lepidium bidentatum* (as *Lepidium piscidium* G.Forst., 249, 39) *Sesbania coccinea* (L.f.) Poir. (as *Aeschynomene coccinea* L.f, 273) and *Scaevola taccada* (Gaertn.) Roxb. (as *S. sericea* Vahl., 504). Compared with our inventory, the five species of the genera *Dicliptera* Juss., *Lepidium* L., *Nicotiana* L., *Scaevola* L. and *Suriana* Plum. ex L. were observed on Îlot Améré in 2019, while *Cynanchum viminale* and *Haloragis prostrata* were observed on Nouaré and Kié islets, respectively, but not on Améré. The three species *Myoporum crassifolium*, *Salsola australis/kali* and *Sesbania coccinea* were not retrieved on any of these islets. The species of *Salsola* L. is a common one on such sandy beaches of islets in New Caledonia and is more or less short-lived and probably prone to vanish after high tide events combined with storms. The date of our inventory (April) differing from the September landing of Cook's crew might also explain its absence. *Myoporum crassifolium* is also a common but long-lived shrub or small tree on rocky (generally limestone) New Caledonian coasts; its absence in 2019 legitimately raises the question whether or not it was really collected from Îlot Améré by the Forsters. The fact that a second species of *Myoporum* Banks & Sol. ex G.Forst, *M. tenuifolium* G.Forst., was also collected and described at the same time from New Caledonia (without locality) renders Forster's assertion even more debatable. It is most probably simply based on an error. The last species, *Sesbania coccinea*, is an even more intriguing case as G. Forster presents it both from the French Polynesian Society Islands and from what has been interpreted as Botany Island (as *Societatis insulae, Botanicesque insula*) by previous botanists (Smith 1985; Sachet 1987; Fosberg 1993). In his manuscript, G. Forster used the term *Botanicesque insula* only once, and for this species, and was thus probably not referring to Cook's Botany Isle but to another island from the Society Islands. Further evidence of this misunderstanding is that what we name *Sesbania coccinea* in New Caledonia is a rare plant only found on calcareous cliffs on Lifou and Ouvéa islands, i.e. not matching at all the ecology of sandy Îlot Améré (see below for nomenclature and typification issues). Among the further 52 species located and said to be occurring at least in New Caledonia (as *Noua Caledonia* but without a more precisely named locality, e.g. in Balade or Botany Island) according to Forster (1786a), one, *Araucaria columnaris*, was undoubtedly observed on Botany Isle (and even drawn by G. Forster as pl. 54); and five, possibly so, namely: *Pavetta opulina* (G.Forst.) DC. listed as *Coffea opulina* G.Forst., 93; *Dianella adenanthera* (G.Forst.) R.J.F.Hend. listed as *Anthericum adenanthera* G.Forst., 149; *Ximenia americana* L. listed as *X. elliptica* G.Forst., 162; *Acacia simplex* (Sparrm.) Pedley listed as *Mimosa mangium* G.Forst., 395; *Breynia disticha* J.R.Forst. & G.Forst. listed as *B. disticha*, 400 (see Table 1 for comparison). Other species listed in Forster (1786a) may also have been collected or seen in New Caledonia and/or Botany Island without being mentioned specifically, especially pantropical or widely distributed Pacific taxa like *Sophora tomentosa* L., or the ones tagged as '*Paffim intra tropicos*' like *Casuarina equisetifolia*. The complex taxonomic and nomenclatural case of *Wollastonia lifuana* (Hochr.) Fosberg is a good example of this uncertainty (see page 50).

William Wales (Wales 1772–1775; Pisier 1974) harvested a large amount of the 'Lamb's Quarters' plant (Figure 3l) and mentioned the "Etoe tree". On board, they ate a meal composed of the plants gathered on the islet with salted pork. Wales did not eat much because he was afraid to become sick after a long period of abstinence and, indeed, those that ate too much suffered from severe digestive pain ("gripings") (Wales 1772–1775).

Sparrman (in Pisier 1974) reported seeing or possibly collecting about 30 species on Botany Isle. He also reported that an officer who collected and ate a fresh salad of *Tetragonia* L. was made sick, probably because he mixed it with some *Euphorbia* or other plants. Since *Tetragonia tetragonoides* actually grows together with two *Euphorbia* species (*Euphorbia obliqua* Endl. and *E.*

tannensis Biehler, see Table 1) on Îlot Améré, Sparrman was probably right.

The botany of Botany Isle from Cook's second voyage specimens

Our intention is to review what is available from herbarium databases, JSTOR Global Plants and specimens mentioned and discussed by previous specialists of Pacific botany and history in order to make a comparison with our 2019 inventory and to cross-check the information retrieved from the literature. Naturally, it was not possible to examine all specimens presumably collected on Botany Isle given the sheer amount of time involved, the high degree of expertise of many families and genera, not to mention the cost of travel to the large number of European herbaria that house Forster´s herbarium material (e.g. Nicolson & Fosberg 2004). As recommended by Hansen and Wagner (1998), large and old herbaria should seek out Forsters' specimens and ensure that any information gained is shared with appropriate organisations. More recently, Nicolson and Fosberg (2004) published an almost full account of the botany of the second Cook expedition. Fosberg (1993) explained in detail the difficulties surrounding the correct lectotypification of Forster species because of a) specimen duplicates are not really true duplicates but, rather, syntypes, b) mixed collections occur at species level and/or at locality level, c) some specimens are without any locality, d) on some specimens the locality has been copied from the published account, e) specimens were not individually labelled but only put into cover folders with only one label outside, f) Forster's original labels were sometimes removed and replaced with new labels by subsequent owners of the collection. To exemplify the nomenclatural problems, the species said to be collected or putatively collected on Botany Isle are treated hereafter with a review when needed.

***Araucaria columnaris* (G.Forst.) Hook.** (Araucariaceae) (Figures 3a, b, 4a–c). Nicolson and Fosberg (2004) found five specimens of *Araucaria* from the second Cook voyage. One supposedly collected by Cook himself in BM (BM000649821!) "on a low island in the South Sea in 1774", and four collected by the Forsters; *Forster 249* in GOET (GOET012735!) as *Cupressus columnaris* without locality, *Forster s.n.* in LE (LE00009049!), (*Forster*) *134* in MW without locality and *Forster s.n.* in UPS (UPS V-136104) without locality. Another specimen, the best so far, but not seen by Nicolson and Fosberg (2004), is the one by Anderson in BM (BM000649849!) from 'Isle of Pines' in 1774. De Laubenfels (1972: 106) and Farjon (2005, in herb.) agree about this specimen being the holotype of the species. Nicolson and Fosberg (2004) think that this is unlikely because Anderson refused to share his specimens with J.R. Forster with whom he was angry. Forster (1786a) described *Cupressus columnaris* as being from New Caledonia and Norfolk Island. In describing and combining *Araucaria columnaris*, Hooker (1852) made reference to "*Dombeya columnaris* G.Forst." from Forster (1786a: 67), although it is described as *Cupressus columnaris*. Hooker's (1852) emendavit and combination of *A. columnaris* was based on newly collected material and young cultivated plants sent by Moore during his trip on H.M.S. *Havannah* with Captain Erskine (Moore 1850; Gâteblé 2015: 24–25). Hooker (1852) did not state that he had really seen any original Forster, Cook or Anderson specimens from New Caledonia but he excluded the Norfolk Island text from Forster (1786a). Since some of the Forster specimens seem to be mixed and comprise New Caledonian and Norfolk Island material, and since it is not known on which specimen the name *C. columnaris* is based, further typification work may be needed. Finally, there is also a single colour drawing of *Araucaria columnaris*, Forster´s pl. 52, depicted in the reprint of G. Forster´s German translation 'Reise um die Welt' (Forster 2007: 496), and in Vorpahl (2018: 431), and housed at the State Library of New South Wales, Sydney, Australia (Vorpahl 2018: 430). The modern printed caption says 'Améré/Neukaledonien' while the original G. Forster handwritten caption is "Isle of Pines on the Southland of New Caledonia".

***Casuarina equisetifolia* L.** (Casuarinaceae) (Figure 3d). There is no specimen of this species said to be collected on Botany Isle (Nicolson & Fosberg, 2004) but the species is common on Îlot Améré (Figure 4b) and could have been collected there. Cook (1777) himself mentioned for Botany Isle the observation of "the Etos tree of Otaheite", which represents *Casuarina* (acc. Beaglehole 1961, as "Etoo"). Most of the Forsters' specimens seem to come from Tahiti (as Otaheite, Otaheiti, Taheitee or Taïti) and/or other Pacific islands (as *Insulis oceani Pacificis, Insulae maris Pacifici intra tropicos*

or Insulae maris austr. intra tropicos). G. Forster's artwork (pl. 254; NHM-UK-L-5623-357-M-1!) is labelled in the BM database as from New Caledonia in September 1774, though 'Taheitee' is written on the sheet.

***Cynanchum viminale* subsp. *brunonianum* (Wight & Arn.) Meve & Liede** (Apocynaceae). According to Nicolson and Fosberg (2004; as *Cynanchum viminale*), no specimen has been located anywhere. However, we found a specimen at BM (BM001252105!) from Cook's second voyage collected in New Caledonia without further location detail. Seemann (1865–1873: 161) reported having seen a Cook specimen from New Caledonia and one of Forster's from 'Botanist Island'. During his stay in Balade, Moore (1850) reported a species of "*Sarcostemma*" that could match the *Cynanchum* the Forsters and/or Cook had collected. During our 2019 botanical survey on Îlot Améré, the species was not found there, but it was found on nearby Nouaré islet. It is thus difficult to say if this sample was indeed collected on Améré or in Balade. This taxon is widely distributed in New Caledonia, especially in coastal habitats, but so far no formal specimen has been collected in the northeast of Grande Terre (incl. Balade, the first New Caledonian collecting area of the Forsters; Liede-Schumann *et al*., 2020).

***Dicliptera caerulea* (G.Forst.) Schinz & Guillaumin** (Acanthaceae) (Figure 3g). According to Hansen and Wagner (1998), *Dianthera caerulea* and *Justicia pubescens* Vahl have the same type while the name *Dicliptera pubescens* (Vahl) Juss. is also accepted by POWO (2020). According to Nicolson and Fosberg (2004), there is a label confusion between *Dicliptera clavata* from Society islands and *D. caerulea* from Botany Isle and the correct name to use is *D. caerulea* (see Fosberg 1993 and Nicolson & Fosberg 2004 for a full list of herbarium specimens from the Forsters, synonymy and typification).

***Haloragis prostrata* J.R.Forst. & G.Forst.** (Haloragaceae). See Nicolson and Fosberg (2004) for a full list of herbarium specimens from Anderson, the Forsters and Sparrman with synonymy and typification.

***Lepidium bidentatum* Montin** (Brassicaceae) (Figure 3k). See Nicolson and Fosberg (2004) for a full list of herbarium specimens from the Forsters and Sparrman with synonymy.

***Myoporum crassifolium* G.Forst.** (Scrophulariaceae). In his Prodromus, Forster (1786a: 44) published four species of *Myoporum*, two from New Zealand (*M. laetum* G.Forst. and *M. pubescens* G.Forst) and two from New Caledonia (*M. crassifolium* and *M. tenuifolium*). According to Nicolson and Fosberg (2004), several specimens identified as "*M. crassifolium*" of Cook's expedition from Anderson, Forsters and Sparrman are available, labelled as from New Caledonia, New Zealand, India or Botany Island. Chinnock (2007) designated the K specimen (K000961360!) from "India" as the lectotype of the name. The name *M. laetum* has also been lectotypified by Chinnock (2007) on the supposedly mixed Forster specimen (K000961364!) said to be collected in New Caledonia and bearing one branch of *M. crassifolium* and three branches of *M. laetum*. Other specimens of the Forsters and Sparrman from New Zealand, South Sea Islands or without locality are available in C, G, K and S (Nicolson & Fosberg 2004). Chinnock (2007) put the name *M. pubescens* under synonymy of *M. laetum* and designated as the lectotype the Forster specimen (UPS V-125556) labelled as Botany Island (*fide* Nicolson & Fosberg 2004) or Botany Bay (*fide* Chinnock 2007; Sweden's Virtual Herbarium Database, 2020). The last name, *M. tenuifolium,* was also lectotypified by Chinnock (2007) on a Forster specimen in BM (BM001040912!) from New Caledonia. Other specimens of Anderson, the Forsters and Sparrman are stored under this name and usually labelled as from New Caledonia and sometimes from New Zealand and South Sea Islands (Nicolson & Fosberg 2004). A further G. Forster drawing in BM (pl. 180; NHM-UK-L-5623-251-M-1!) is labelled from New Caledonia on 6 September 1774 and this date matches the Balade locality. From the above discussion and the mixture of specimens and localities for the specimens recorded under the names *M. crassifolium*, *M. laetum* and *M. pubescens*, plus the fact that we did not see any *Myoporum* species on any of the three islets, it is legitimate to ask if a *Myoporum* specimen was collected on Botany Isle at all, or whether the name *M. crassifolium* should be removed from the flora of New Caledonia. In addition, the sandy habitat of Îlot Améré does not fit well with the ecology of this *Myoporum* (though it sometimes occurs on sandy islets) in New Caledonia. In contrast, there is a high probability for *M. tenuifolium* having been collected in Balade, New Caledonia.

***Nicotiana forsteri* Roem. & Schult.** (Solanaceae)

(Figure 3j). See Nicolson and Fosberg (2004) for the single herbarium specimen from the Forsters and typification, and Marks (2010) for synonymy. A few individuals of this species were seen on Îlot Améré, only, and not on the other two islets (Table 1).

***Salsola* aff. *australis* R.Br.** (Amaranthaceae). See Nicolson and Fosberg (2004, as *Salsola kali*) for the two herbarium specimens (GOET 012581!, MW) from the Forsters. The species of *Salsola* usually cited in the literature for New Caledonia is *S. kali* L. but we prefer to assign to it the name *S.* aff. *australis* before a complete revision of the genus in the region becomes available (see Borger *et al.* 2008; Chinnock 2010; and Mosyakin 2018 for taxonomic discussion of Australian taxa).

***Scaevola taccada* (Gaertn.) Roxb.** (Goodeniaceae). See Nicolson and Fosberg (2004, as *Scaevola sericea*) for a full list of herbarium specimens from Cook and the Forsters with synonymy and typification.

***Sesbania coccinea* (L.f.) Poir.** (Fabaceae). Several of the Forsters' specimens are listed as originating from New Caledonia, Botany Island, New Zealand and Society Islands (Nicolson & Fosberg 2004). According to Nicolson and Fosberg (2004), there is no single specimen that bears only New Caledonia or Botany Island on the labels. One (in S-LINN) is said to be from "Nova Zeelandia", another one (in P) is said to be from "Taïti et Nouvelle-Calédonie" and the last one (in UPS) from "Society Island et Botany Island" Nicolson and Fosberg (2004). It was not possible to find any locality data on the high-resolution scan of the P specimen (P00320361!). The UPS specimen (V-129250) could not be seen online for further verification but is portrayed in Sachet (1987: 19). Another specimen, not cited by Nicolson and Fosberg (2004), is in Munich (M-0233481!). It is said to be from "*Insula arenosa prope Novam Caledoniam*" on a supplementary label not in Forster´s handwriting. The type of the name *Aeschynomene coccinea* L.f. is the specimen seen by Linnaeus's son now held in S-LINN (LINN-HS1208-5!), which is cited from New Zealand in Linnaeus's (1782) protologue. The label is most probably not in Forster's handwriting, so this locality is even more dubious, though Merrill (1954b) wrote New Caledonia was the intended (Linneaus f.?) locality. *Fide* Sachet (1987) and Butaud (pers. comm. 2020) the holotype does not match Society Islands, or even French Polynesian plants, so the proper locality might rather be Niue, Tonga or even Vanuatu. As previously stated, the species was not seen during our botanical inventory of the Îlot Améré, and the ecology of this sandy island does not fit the calcareous rocks it prefers on Lifou and Ouvéa. Although Fosberg (1993) considered the LINN specimen as "one of the relatively few Forster specimens that may be unequivocally considered holotypes", in our view, the nomenclature and taxonomy of *S. coccinea* need to be revised in light of these new facts. In consequence, the Lifou and Ouvéa taxon might eventually be treated as a species or subspecies of its own.

***Sophora tomentosa* L.** (Fabaceae). Seemann (1865–1873: 66) reported that he saw a specimen of this species collected by Forster on 'Botanists' Island' but nobody has been able to relocate this specimen. *Sophora tomentosa* is a common plant on Îlot Améré and on most coastal areas of New Caledonia and it would not be surprising if the Forsters collected a specimen there. It can also be hypothesised that some locality labels were mixed with the ones of *Sesbania coccinea*.

***Suriana maritima* L.** (Surianaceae) (Figure 3h, i). See Nicolson and Fosberg (2004) for a full list of herbarium specimens from Anderson and the Forsters. *Suriana maritima* (Figure 3h) is also under the (presumably two) plants from Botany Isle drawn by G. Forster in Sept. 1774. Two rough but significant pencils sketches are part of Georg Forster´s "Skizzenbuch" kept at the Forschungsbibliothek Gotha (Germany); one partial drawing (no. 39) just showing the inflorescence is depicted here (Figure 3h). This sketch is without a caption, but the corresponding no. 21 (showing the habit of a plant) says "*Suriana maritima*, Sandy Isl., New Caledonia, Sept 1774" (cf. also Nicolson 1998).

***Wollastonia lifuana* (Hochr.) Fosberg** (Asteraceae) (Figure 3m). The original Forster specimens of *Buphthalmum helianthoides* G.Forst. (K001065750!) and *Buphthalmum uniflorum* G.Forst. ex Willd. (B-W16422-010!) were also retrieved in order to check if they might not belong to *Wollastonia lifuana*, a common species found on Îlot Améré and many other New Caledonian shores. The first specimen belongs to *Wollastonia biflora* (L.) DC., most probably collected at Balade and drawn by G. Forster on the ship after leaving New Caledonia and Botany Island, on its way to Norfolk Island, 06 October 1774 (*fide* Nicolson 1998; Nicolson & Fosberg 2004; see also Fosberg 1993). An exquisite coloured drawing is

part of Forster´s Skizzenbuch under no. 70, subtitled as "Anthemis proteus". The second specimen represents the type of *W. uniflora* (Willd.) Orchard and was collected on Norfolk Island. However, there is another Forster specimen in BM (BM000820296!) also said to be collected on "*Norfolk Island Oceani Pacifici*" that matches *W. lifuana*, a species endemic to New Caledonia and Vanuatu (Wagner & Robinson 2001; Orchard 2013; Edwards *et al.* 2018). Contacted on that matter, Tony Orchard agreed that this specimen belongs to *W. lifuana* and has published a correction for its typification (Orchard 2019). *Wollastonia lifuana* should then be added to the specimens and list of species collected on Botany Isle. Our survey retrieved this species, and none of its congeners on all three islets (Table 1).

The botany of Îlot Améré based on recent specimens at NOU and our 2019 botanical inventory of Améré and nearby Kié and Nouaré islets, compared with the historical data

The vegetation covering these Pacific coral sand islands is typically dominated by some littoral forest in the centre, surrounded by littoral shrubs and beach vegetation (cf. Butaud & Jacq 2015, Figure 4). During our 2019 botanical inventory, 64 species were observed and identified on Améré, 74 on Kié and 59 on Nouaré (Table 1). The 46 specimens from Améré housed at NOU [21 from H.S. MacKee, 1 from J.-F. Cherrier (leg. H.S. MacKee), 1 from T. Sevenet, 7 from B. Suprin and 16 from J.-M. Veillon] represent 30 species to which two more species can be added from Veillon's pers. comm. in 2019 (Table 1). There are eight additional M. Le Corre specimens at NOU from "Réserve Merlet" without data, collected on Améré or Kié, and 3 specimens (2 Suprin, 1 MacKee) from Nouaré islet. In crosschecking our Améré inventory with specimens at NOU, three species (one determined as *Dianella stipitata* Schlittler but most probably *Dianella adenanthera*, as well as *Pavetta opulina* and *Spinifex sericeus* R.Br.) were not seen in our 2019 survey (Table 1). The five species recorded during Cook's second voyage and not seen in 2019 were discussed in the previous paragraph. Comparing our data, Forster's (1777) assertion "it contained in so small a space a flora of near thirty species", suggests that they saw fewer than half of the species that grow on Îlot Améré while collecting, and reported a maximum of 15 taxa (Table 1). With 74 species, Îlot Kié (ca 8.5 ha, 520 x 230 m) has the richest flora of the three islets. Îlot Améré is the second most species-rich islet with 64 (+3) taxa for a surface of ca. 5.6 ha (510 x 160 m). Îlot Nouaré (3.5 ha, 510 x 120 m), which is outside of the "Yves Merlet Integral Natural Reserve" has the fewest species, with 59 in total. With regard to the number of species per hectare, Îlot Nouaré is the richest with 16.8 species/ha, Îlot Améré is the second with 11.4 species/ha and Îlot Kié is the third with 8.7 species/ha. This plant diversity, ranging from 59 to 74 species, can be considered high for such small, sandy islets, but it is in fact relatively low compared to rainforests on mainland Grande Terre where, for example, Ibanez *et al.* (2018) found an average of 95 species of plants with a dbh ≥ 10 cm in 1 ha plots. The endemism rate is also very low, with only ten taxa (Table 1) considered as endemic for New Caledonia by Munzinger *et al.* (2020). Among the 89 established species recorded (in 50 different families) from at least one islet (2019 inventory, plus three species from specimens at NOU), this makes a relatively low endemism percentage of 11.2 % compared to the average 75.1% for the whole New Caledonian native flora (Munzinger *et al.*, 2020)—but it is much in accordance with the average 11.4% endemism recorded for halophytic vegetation (Morat *et al.*, 2012). The most unusual findings from our inventories are probably the presence of the endemic species of the genera *Ficus* Tourn. ex L., *Ixora* L. and *Parsonsia* R.Br. on the richest island, Kié (Table 1). In addition to the established plant species recorded in Table 1, we were also able to record the presence of naturally dispersed and sea-water buoyant fruits on the beaches of Îlot Améré and Îlot Kié (*Heritiera littoralis* Aiton) and Nouaré [*Barringtonia asiatica* (L.) Kurz].

Retrospectively, it could be asked why more than twice the number of species reported by the *Resolution*'s team was found during our research? It is possible that the time they had on the island was limited. Forster (1778) tells us that they, after rowing to shore, had a brief reconnaissance ("…das Land ein wenig recognoscirt…"), but rowed back to the *Resolution* to have lunch on board. They then returned to the islet to spend the afternoon there until sunset. While botanising they also shot birds. One discrepancy, however, remains: in Hoare (1982: 661), J.R. Forster reported: "a small islet, full of such pyramidal things". And G. Forster, during the journey, reported that

the little island was covered in *Araucaria* ("… eine kleine Insel…mit säulenförmigen Bäumen überwachsen …"). Nowadays, *Araucaria* inhabits only the eastern part of the island, covering probably less than 15% of the island´s landmass in all (Figure 4a, b). We also learned that Cook most probably approached the island from the (north)-west, and probably landed on Botany Isle by rowing a boat through the only narrow channel on the north-west, where no *Araucaria* actually grow—contrast this with G. Forster's (1778) statement that they, upon leaving the boat, were immediately attracted by a kind of cypress ("Die schlanken hohen Bäume zogen, gleych beym Aussteigen aus dem Boote, unsere ganze Aufmerksamkeit auf sich"). There are good reasons to believe that deforestation driven by naval interest in the trees occurred on these islets (cf. Gill 1976), as suggested by Cook. In any case, it can only be speculated whether or not *Araucaria* was really more frequent on the island in the past.

From a conservation point of view, and based on our actual inventory (Table 1), it can be stated that very few species are introduced and invasive. The conservation status of these islets therefore seems very good. The worst weedy exotic species on the three islets is *Passiflora suberosa* L. Other species that might be considered as more or less recent human introductions are *Achyranthes aspera* L., *Cocos nucifera* L., *Morinda citrifolia* L., *Rivina humilis* L. and *Stenotaphrum secundatum* (Desv.) C.E.Hubb., but they do not currently pose a threat to the native flora. Nevertheless, *Rivina humilis* can become weedy. The recently introduced myrtle rust *Austropuccinia psidii* (Soewarto *et al.*, 2018) is severely damaging the endemic *Eugenia gacognei* Montrouz., as we saw many trees close to death on the three islets. Ironically, the main threat to the overall vegetation of these islets may be the protected native bird *Ardenna pacifica* (*Puffinus pacificus;* fam. Procellariideae), the wedge-tailed shearwater, which forms large colonies. Neither Cook nor the Forsters reported on these birds or on the burrows they dig, maybe because they landed before their breeding season (November–April) or because there was no colony on Botany Isle 245 years ago. Pandolfi Benoit and Bretagnolle (2002) indeed reported many *Ardenna pacifica* breeding pairs (5,501–12,000 on Améré, 2,001–5,500 on Kié and Nouaré) with high numbers (0.4–0.75 on Améré and Kié, 0.2–0.4 on Nouaré) of breeding pairs/m^2 (a breeding pair is counted for each occupied burrow). In most places on Améré and Kié, the sandy substrate is so full of burrows that shrubs and trees are not well rooted and are thus prone to falling down more easily during tropical storms. The trees and shrubs are also suffering from drought and their regeneration is low, probably intensified by the many burrows.

Concluding remarks

Nearly 250 years after Cook's visit to Botany Isle, a number of questions concerning the species and specimens really collected on Îlot Améré still remain unanswered. By compiling available literature and specimens, and by comparing these with our 2019 inventory, these questions have been addressed to the extent possible and a review conducted. Some nomenclatural and taxonomic problems were already well known for many of the Forsters' specimens collected during Cook's second voyage, and a few more have been identified. The lectotypification of additional taxa has been avoided owing to too much remaining uncertainty, but it is hoped that this account will encourage specialised taxonomists and nomenclaturists to do so, as already done by Orchard (2019) following our query. Some focused studies using the latest DNA sequencing techniques on extant historical specimens might help to resolve some remaining typification questions.

The localisation of Botany Isle, apparently first synonymised with Îlot Améré by Bouquet de la Grye, was confirmed to be accurate. However, as an unexpected result, we found some mistakes in the interpretation of Cook's maps and the localisation of certain named capes.

Botany Isle is home to more than 60 species (our inventory); Forster, Cook and Sparrman each reported about 30 species seen/collected on the islet, but only ten species are documented with herbarium specimens that most likely originated from Botany Isle, and only 13 species were mentioned specifically. Thus, it is possible to conclude that, despite the promising naming of 'Botany Isle'/'Botany Island', neither Cook nor the Forsters found it possible to describe the flora and vegetation of Îlot Améré in comprehensive detail, whether through their textual descriptions or their documented material gatherings. It is conceivable that the time they had on the island was limited and that their attention was much drawn to "Cook's pine", *Araucaria columnaris*, surely the most impressive plant seen by them in New Caledonia.

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Table 1. Vascular plant species recorded from Améré, Kié and Nouaré islets. The numbers refer to the relative abundance of the species: -- = not documented, 1 = rare, 2 = quite common, 3 = very common. Taxon names in bold refer to NC endemics; numbers in bold refer to those species where we prepared specimens and deposit at NOU. **C**, refers to existing historical specimens from Cook's second voyage; **H**, refers to herbarium specimens in NOU; **V**, refers to Veillon's pers. comm. of species seen on 10 December 1981; **T**, refers to Cook's second voyage literature (Cook 1772–1775; Forster 1777; 1786a, 1786b; Pisier 1974; Hoare 1982).

Taxon	2019 Inventory and abundance			NOU Herbarium specimens		Botany Isle specimens and literature
	Améré	Kié	Nouaré	Améré	Nouaré	
Abutilon indicum (L.) Sweet	1	1	--			
Acacia simplex (Sparrm.) Pedley	2	2	2			
Achyranthes aspera L.	2	2	2	H		
Allophylus timoriensis (DC.) Blume	--	**1**	--			
Alyxia stellata (J.R.Forst. & G.Forst.) Roem. & Schult.	2	2	--	H		
***Araucaria columnaris* (G.Forst.) Hook.**	2	3	--	V		T, C
Asplenium nidus L.	--	2	2			
Boerhavia acutifolia (Choisy) J.W.Moore	**2**	2	2	H		
Breynia disticha J.R.Forst. & G.Forst.	--	1	--			
Cakile maritima Scop.	--	1	1	H		
Calophyllum inophyllum L.	1	1	--			
Canavalia rosea (Sw.) DC.	2	2	2			
Cassytha filiformis L.	2	2	2			
Casuarina equisetifolia L.	2	2	2			T
Celastrus subspicatus Hook.	--	1	--			
Celtis paniculata (Endl.) Planch.	**3**	2	2			
Cocos nucifera L.	2	2	2			
Colubrina asiatica (L.) Brongn. var. *asiatica*	2	2	2	H		

Taxon	2019 Inventory and abundance			NOU Herbarium specimens		Botany Isle specimens and literature
	Améré	Kié	Nouaré	Améré	Nouaré	
Cordia subcordata Lam.	2	2	2	H		
Crinum asiaticum L.	1	--	--			
Cynanchum viminale subsp. *brunonianum* (Wight & Arn.) Meve & Liede	--	--	**1**			T, C?
Dianella stipitata Schlittler	--	--	--	H		
***Dicliptera caerulea* (G.Forst.) Schinz & Guillaumin**	1	--	2	H		T, C
Elaeodendron curtipendulum Endl.	3	3	2	H		
Eragrostis scabriflora Swallen		**1**				
***Eugenia gacognei* Montrouz.**	3	3	**3**	H		
Euphorbia obliqua Endl.	2	1	2	H		
Euphorbia tannensis Biehler subsp. *tannensis*	1	2	2	H		
Excoecaria agallocha L.	--	--	1			
***Ficus* cf. *lifouensis* Corner**	--	**1**	--			
Ficus obliqua G.Forst.	2	2	2			
Flagellaria indica L.	--	--	1			
Guettarda speciosa L.	2	3	2			
Guilandina bonduc L.		1	3			
Gymnema tricholepis Schltr.	**3**	3	3			
Gynochthodes cf. *myrtifolia* (A.Gray) Razafim. & B.Bremer	**1**	1	--			
Haloragis prostrata J.R.Forst. & G.Forst.	--	1	--			T, C
Heliotropium arboreum (Blanco) Mabb.	2	2	2			
Hernandia nymphaeifolia (C.Presl) Kubitzki	1	1	2	H		
Hibiscus tiliaceus L.	--	2	2			
Ipomoea pes-caprae (L.) R.Br.	1	1	2			
Ipomoea violacea L.	1	2	2			
***Ixora collina* (Montrouz.) Beauvis.**	--	**2**	--			
Jasminum didymum G.Forst. subsp. *didymum*	1	1	--			
Lepidium bidentatum Montin	2	2	2	H		T, C
Lepturus repens (G.Forst.) R.Br.	1	1	1			
Manilkara dissecta (L. f.) Dubard	3	3	3	H		
***Meryta denhamii* Seem.**	--	2	--			
Micromelum minutum (G.Forst.) Wight & Arn.	--	**1**	--			
Microsorum punctatum Copel.	1	**2**	2	V		
Mimusops elengi L.	3	3	3	H		
Morinda citrifolia L.	--	1	--			
Murraya crenulata (Turcz.) Oliv.	2	--	--	H		
Myoporum crassifolium G.Forst.	--	--	--			T, C?
Myrsine novocaledonica* (Mez) Ricketson & Pipoly subsp. *novocaledonica	2	2	--			
Nicotiana forsteri Roem. & Schult.	1	--	--	H		T, C

Taxon	2019 Inventory and abundance			NOU Herbarium specimens		Botany Isle specimens and literature
	Améré	Kié	Nouaré	Améré	Nouaré	
Ochrosia elliptica Labill.	2	3	2	H		
Oplismenus hirtellus (L.) P. Beauv.	**1**	--	--			
Pandanus tectorius Parkinson ex Du Roi	2	2	2			
***Parsonsia scabra* (Labill.) Markgr.**	--	**1**	1			
Passiflora suberosa L.	3	3	3	H		
Pavetta opulina (G.Forst.) DC.	--	--	--	H		
Pemphis acidula J.R.Forst. & G.Forst.	--	1	2			
Phymatosorus grossus (Langsdorff & Fischer) Brownlie	1	1	--	H		
Pisonia aculeata L.	1	1	--			
Pisonia grandis R.Br.	3	3	3	H		
***Planchonella cinerea* (Pancher ex Baill.) P.Royen**	3	3	3	H	H	
Planchonella linggensis (Burck) Pierre	1	2	1		H	
Premna serratifolia L.	2	3	--			
Rivina humilis L.	3	3	3	H		
Salsola aff. *australis* R.Br.	--	--	--			T, C?
Sarcomelicope cf *simplicifolia* subsp. *neoscotica* (McGill. & P.S.Green) T.G.Hartley	**1**	--	--			
Scaevola taccada (Gaertn.) Roxb.	2	2	2			T, C?
Secamone elliptica R.Br.	--	--	1			
Sesbania coccinea (L.f.) Poir.	--	--	--			T, C?
Sesuvium portulacastrum (L.) L.	3	3	3	H		
Solanum tetrandrum R.Br.	2		1	H		
Sophora tomentosa L.	2	2	2			C?
Spinifex sericeus R.Br.	--	--	--	H		
Stenotaphrum micranthum (Desv.) C.E.Hubb.	2	2	1			
Stenotaphrum secundatum (Walter) Kuntze	1	2	2			
Suriana maritima L.	3	3	3	H		T, C
***Terminalia rubricarpa* Baker f.**	**1**	1	2			
Tetragonia tetragonoides (Pall.) Kuntze	1	1	2	H		T
Thespesia populnea (L.) Sol. ex Corrêa	1	2	2			
Thuarea involuta (G.Forst.) R.Br. ex Sm.	2	2	2	H		
Triumfetta procumbens G.Forst.	1	2				
Vigna marina (Burm.) Merr.	1	1	2			
Volkameria inermis L.	1	1	2			
Wikstroemia indica (L.) C.A.Mey.	--	2	--			
Wollastonia lifuana (Hochr.) Fosberg	2	2	2	H		C
Ximenia americana L.	--	--	**1**			
Total	64	74	59	32	2	15?

Muelleria

39: 59–73

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ROYAL BOTANIC GARDENS VICTORIA

Amanita hiltonii (Amanitaceae), a common but frequently misidentified mushroom in southwestern Australia, and reconsideration of *A. albifimbriata* and *A. brunneibulbosa*

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Introduction

In 1976, the Australian Biological Resources Study funded Derek Reid, a mycologist from Kew, to monograph the important mushroom genus *Amanita* Pers. He visited Western Australia (WA), South Australia and Victoria, where he collected with local mycologists and also examined type material held in Australian and other herbaria. His monograph (Reid 1980) included 46 taxa, including newly described species and a key. One of the new species was *A. hiltonii* D.A.Reid, named after Roger Hilton, a lecturer in mycology at the University of WA. Its distinguishing features are its medium size, thick-set stature, a white or whitish pileus which is completely covered with the universal veil, off-white to yellowish lamellae, narrowly elliptical, amyloid spores, and abundant clamp connections. No macroscopic photographs or drawings were published with the description and no material was left in Perth (although an isotype was deposited by K in DAR); the species is not mentioned in various publications on fungi in WA (Griffiths 1985; Bougher & Syme 1998; Robinson 2003). Its name appears to have been forgotten.

In 1991 Miller described several new *Amanita* spp. from WA following a visit in 1989 (Miller 1991). These include *A. albifimbriata* O.K.Mill., a large species with an ivory white pileus with superficial white warts, napiform

Abstract

Amanita hiltonii D.A.Reid is a common white mushroom in forested areas of southwestern Western Australia. It has been frequently misidentified as *A. ananiceps* (Berk.) Sacc. or *A. preissii* (Fr.) Sacc. Its distinguishing characters include its large size, conspicuous appendiculate cap margin, cream coloured gills, strong, unpleasant smell, amyloid, ellipsoid to elongate spores, and abundant clamp connections. Genetic sequences show collections form a well-supported clade in subgen. *Amanitina* (E.-J.Gilbert) E.-J. Gilbert sect. *Roanokenses* Singer ex Singer. *Amanita albifimbriata* O.K.Mill. is similar in appearance and microanatomy to *A. hiltonii* and these two species are synonymised. *Amanita brunneibulbosa* O.K.Mill. does not differ significantly from *A. kalamundae* O.K.Mill. and has been synonymised with it.

***Keywords*:** Basidiomycota, molecular phylogeny, taxonomy

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bulb, white fimbriate lamellae, a partial veil that has disappeared by maturity, ovate to shortly elliptical amyloid spores, and the odour of old ham bones or old tennis shoes. Clamp connections were not seen. Miller (1991) distinguished *A. albifimbriata* from *A. ananiceps* (Berk.) Sacc. [as *ananaeceps*] (a species described from Tasmania), based upon the absence of clamp connections. However, examination of the type of *A. albifimbriata* (PERTH02224291, OKM 23729) by EMD, showed clamp connections are present in all tissues. Thus, the distinctive character used by Miller (1991) to distinguish *A. albifimbriata* from *A. ananiceps* is not supported by careful examination.

Reid (1980) examined the holotypes of both *A. hiltonii* and *A. ananiceps*. Their macroscopic descriptions are similar, allowing for the variations that occur among collections of the same species. However, Reid separated them on the basis of the abundance of clamp connections at the base of basidia and in the universal veil on the pileus; clamp connections are abundant in *A. hiltonii* and scant in *A. ananiceps*. Bas (1969) also examined the holotype of *A. ananiceps* and stated that clamp connections are frequent without elaborating on their frequency in different tissues. A comparison of the types of *A. hiltonii* (K(M)204139) and *A. albifimbriata* shows they do not differ significantly in any characters; the two taxa are synonymised in this paper.

There are other large, white amanitas with clamp connections which have been described from southern and eastern Australia. These include *A. farinacea (*Sacc.) Cleland & Cheel which is similar to *A. ananiceps*; it was described from Queensland. After examining the types of both species, Bas (1969) and Reid (1980) were unable to confidently separate them and suggested that further collections from the type locations would be needed before deciding whether these taxa are the same. Wood (1997), in his monograph of *Amanita* spp. from eastern Australia, listed *A. ananiceps, A. farinacea* and *A. hiltonii*. His identifications were based on the best fit with descriptions in Reid (1980) and Bas (1969). He distinguished these three species in his key on the basis of spore shape, whether the universal veil on the pileus is powdery (*A. farinacea*) or more or less membranous-fibrillose (*A. ananiceps* and *A. hiltonii*), and the presence (*A. hiltonii*) or absence (*A. ananiceps*) of a membranous partial veil. However, in the species description of *A. hiltonii*, he stated that the partial veil is absent. As outlined above, there is considerable confusion over the identity and distribution of these species which could be resolved through comparison of DNA from the type specimens or from additional collections from the type localities.

Miller (1991) also described *A. brunneibulbosa* O.K.Mill. from the southwest of WA. The distinctive features are a viscid brown pileus, with easily detached patches of white universal veil, a white, floccose partial veil, small oval bulb, ovoid to short elliptical amyloid spores and no clamp connections. However, examination of the type (PERTH07587457, OKM 23671, E 539) by EMD, showed clamp connections are present in the lamellae and at the base of basidia.

Amanita kalamundae O.K.Mill. [as *A. kalamundi*] was also described from the southwest of WA (Miller 1991). Its distinctive characters are a brown pileus, orange universal and partial veil, yellow tinted flesh, subglobose to elongate amyloid spores, and no clamp connections. However, examination of the type (PERTH02224283, OKM 23975) by EMD found clamp connections are present in the lamellae. In an expanded description, based on additional collections of this common species, the yellow colouration of the universal veil, partial veil, flesh and bulb are interpreted as a result of ageing or bruising (McGurk *et al.* 2016). Comparison of collections of *A. brunneibulbosa* (PERTH07587457, PERTH07547706, PERTH07547897), together with images of these collections provided by N.L. Bougher, show that they cannot be distinguished from *A. kalamundae*. Accordingly, the two taxa are synonymised in this paper.

Amanita is a large, cosmopolitan genus. Its phylogeny has been recently revised by Cui *et al.* (2018), using concatenated data sets of nuLSU (28S nuclear ribosomal large subunit rRNA gene), *β-tubulin, ef1-α* (elongation factor 1-α), and *rpb2* (RNA polymerase II) gene regions. They recognised three subgenera: *Amanita, Amanitina (*E.-J. Gilbert) E.-J. Gilbert and *Lepidella* Beauseigneur. *Amanita hiltonii* falls within subgen. *Amanitina* because it has amyloid spores, a bulbous stipe base, and is likely to be mycorrhizal. Within *Amanitina* they recognised six sections, on the basis of pileus margin, form of the universal veil, and presence of clamp connections: sect. *Amidella* (E.-J. Gilbert) Kinrad & Maubl., sect. *Arenariae* Zhou L. Yang, Y.Y. Cui & Q. Cai, sect. *Phalloideae* (Fr.) Quél.,

sect. *Roanokenses* Singer ex Singer, sect. *Strobiliformes* Singer ex Zhou L. Yang, Y.Y. Cui & Q. Cai, and sect. *Validae* (Fr.) Quél. From their key, the characteristics of an appendiculate pileus margin and presence of clamp connections place *A. hiltonii* in sect. *Roanokenses*.

In this paper, nuLSU sequences were used to check whether *A. hiltonii* falls within sect. *Roanokenses*, while other gene regions were used to determine the variation between collections of *A. hiltonii* from the southwest of WA. An expanded description of *A. hiltonii* is provided, based on a larger number of collections than those available to Reid, while *A. albifimbriata* is synonymised with *A. hiltonii, and A. brunneibulbosa* is synonymised with *A. kalamundae*.

Methods

Morphology and anatomy

The methodology used for describing the macroscopic and microscopic characters largely follows Tulloss (2000). Colour names, including the colour of spores in deposit and other shades of white to cream (designated by the letter A–G), follow those of the Royal Botanic Garden, Edinburgh (1969) while colour codes are from Kornerup & Wanscher (1983). In the descriptions of basidiospores (and basidia) the notation [x/y/z] denotes x basidiospores measured from y basidiomes from z collections. Biometric variables for spores follow Tulloss (2000), i.e. '**L** = the average spore length computed for one specimen examined and the range of such averages, **L'** = average spore length computed for all spores measured, **W** = the average spore width computed for one specimen examined and the range of such averages, **W'** = average spore width computed for all spores measured, Q = the length/breadth for a single spore and the range of the ratio of length/breadth for all spores measured, **Q** = the average value of Q computed for one specimen examined and the range of such averages, **Q'** = the average value of Q computed for all spores measured'. Author citations follow Index Fungorum (http://www.indexfungorum.org/Names/Names.asp). Herbarium codes follow Index Herbariorum (http://sweetgum.nybg.org/science/ih/).

DNA extraction, amplification and sequencing

DNA extraction, amplification and cloning of the ITS (nuclear ribosomal internal transcribed spacer region), amplification of the nuLSU, *ef1-α*, *rpb2* and *β-tubulin* regions follow the methodology described in Davison *et al.* (2017). Sequence data were assembled with Geneious version 10.0.5 (Geneious undated). Additional sequences were accessed from GenBank (http://www.ncbi.nlm.nih.gov/) (Tables 1 and 2). Maximum likelihood phylogenetic trees were built using Mega version 5 (Tamura *et al.* 2011). The best model for each dataset was determined using the Model Function in MEGA. The General Time Reversible model (Taravé 1986) with gamma distribution rates with invariant sites was used to determine the placement of *A. hiltonii* in subgen. *Amanitina* using the nuLSU gene region. The Kimura 2-parameter model (Kimura 1980) with gamma distribution rates was used for the *ef1-α* and *β-tubulin* gene regions, and with invariant sites for the *rpb2* gene region. The Tamura Nei model (Tamura & Nei 1993) with gamma distribution rates with invariant sites was used for concatenated *β-tubulin, rpb2, ef1-α* and nuLSU gene regions. A bootstrap consensus tree was inferred from 500 replicates.

Results

Phylogenetic results

The nuLSU is the only gene region available from GenBank for the type species of sections within subgen. *Amanitina*. These, together with additional species (Table 1), show *A. hiltonii* forms a clade with good support within sect. *Roanokenses* (Figure 1). *Amanita hiltonii* clusters close to, but is separate from *A. farinacea*.

Additional gene regions (*ef1-α, β-tubulin* and *rpb2*) are available for some of the *A. hiltonii* collections and two additional species (*A. carneiphylla* and *A. preissii*) from the southwest of WA (Table 2). Phylogenetic analyses by the maximum likelihood method of the *ef1-α* (445 base pair positions) (Figure 2a) and *β-tubulin* (204 base pair positions) (Figure 2b) gene regions show *A. hiltonii* collections cluster in a well-supported clade, although deeper relationships are not resolved. Only one *rpb2* sequence is available for phylogenetic analysis (Figure 2c). This, together with concatenated *β-tubulin ef1-α rpb2* and nuLSU sequences, shows *A. hiltonii* is distinct from other species in sect. *Roanokenses* (Figure 2d), although support values are low.

Table 1. GenBank numbers for nuLSU sequences, including type species, from the different sections of *Amanita* subgen. *Amanitina*. Sequences in bold have been generated for this work.

Section	*Amanita* spp.	Voucher number	Location	nuLSU
Amidella	*A. volvata* (Peck) Lloyd	KA12-1367	Gyeongbuk, Korea	KF245907
	A. brunneomaculata Zhu L. Yang, Y.Y. Cui & Q. Cai	HKAS 70032	Yunnan, China	MH486411
	A. lanigera Y.Y. Cui, Q. Cai & Zhu L. Yang	HKAS 89030	Yunnan, China	MH486621
	A. parvicurta Y.Y. Cui, Q. Cai & Zhu L. Yang	HKAS 101215	Yunnan, China	MH486745
Arenariae	*A. arenaria* (O.K. Mill. & E. Horak) Justo	PERTH07586329, VPI679 (type)	City of Albany, WA	GQ925382
	A. wadulawitu McGurk, E.M. Davison & E.L.J. Watkin	PERTH09144390	Shire of Serpentine-Jarrahdale, WA	**MN918098**
	A. peltigera	AD282185	Kangaroo Island, SA	MN900628
Phalloideae	*A. phalloides* (Vaill. ex Fr.) Link	HKAS75773	China	JX998060
	A. djarilmari E.M. Davison	PERTH08776067	Shire of Cuballing, WA	KY977704
	A. marmorata (Cleland & E.-J. Gilbert) E.-J. Gilbert	PERTH08690596	Shire of Denmark, WA	KY977711
Roanokenses	*A. roanokensis* Coker	FLAS-F-60892	Florida, USA	MH620252
	A. avellaneifolia Zhu L. Yang, Y.Y. Cui & Q. Cai	HKAS80011	Yunnan, China	MH486378
	A. carneiphylla O.K. Mill.	PERTH08793530	City of Melville, WA	MN911351
	A. elliptica Q. Cai, Y.Y. Cui & Zhu L. Yang	HKAS96797	Hainan, China	MH486488
	A. farinacea	PSC 2529	South Australia	HQ539692
	A. gymnopus Corner & Bas	HKAS89031	Yunnan, China	MH486583
	A. manginiana Har. & Pat.	HKAS56933	China	KJ466438
	A. miculifera Bas & Hatan.	HKAS101425	Shenyang, China	MH486643
	A. modesta Corner & Bas	HKAS79688	China	KJ466440
	A. neo-ovoidea Hongo	HKAS89025	Yunnan, China	MH486656
	A. ochrophylla (Cooke & Massee) Cleland	PSC 1127	South Australia	HQ539717
	A. preissii (Fr.) Sacc.	PERTH 8690766	Kings Park, WA	KY290654
	A. roseolifolia Y.Y. Cui, Q. Cai & Zhu L. Yang	HKAS 101403	Hainan, China	NG_064593
	A. virgineoides Bas	HKAS77278	Hainan, China	MH486945
	A. yenii Zhu L. Yang & C.M. Chen	HKAS89016	Yunnan, China	MH486952
Strobiliformes	*A. strobiliformis* (Paulet ex Vittad.) Bertill.	MB-001177	Germany	MH486895
	A. cinereopannosa Bas	RET 318-8	Maine, USA	HQ539678
	A. aspericeps Y.Y. Cui, Q. Cai & Zhu L. Yang	HKAS 77783	Guangdong, China	MH486372
	A. cinereoradicata Y.Y. Cui, Q. Cai & Zhu L. Yang	HKAS63641	Yunnan, China	MH486452
Validae	*A. excelsa* (Fr.) Bertill.	HKAS96169	Austria	MH486492
	A. flavoconia G.F Atk.	BW_PH22	Massachusetts, USA	HQ539693
	A. citrina Pers.	BW JLR 102106-1	New Jersey, USA	HQ539679
Amanita	*A. subglobosa* Zhu L. Yang (outgroup)	HKAS58837	China	JN941152
	A. hiltonii	PERTH09004564	Shire of Mundaring, WA	**MT364456**
	A. hiltonii	PERTH09004580	Shire of Manjimup, WA	**MT364457**
	A. hiltonii	PERTH09004599	Shire of Cuballing, WA	**MT364455**

Table 2. GenBank numbers for sequences from sect. *Roanokenses* for comparison with *Amanita hiltonii*. Sequences in bold have been generated for this work.

Amanita spp.	Voucher number	Location	GenBank numbers			
			ITS	*ef1-α*	*rpb2*	*β-tubulin*
A. avellaneifolia	HKAS80011	Yunnan, China		MH508680	MH485872	MH485410
A. carneiphylla	PERTH08793530	City of Melville, WA		MN909832	**MN928556**	**MN909829**
A. carneiphylla	PERTH08793565	Shire of Cuballing, WA		**MN909833**	**MN928557**	**MN909830**
A. elliptica	HKAS96797	Hainan, China		MH508765	MH485966	MH485490
A. gymnopus	HKAS89031	Yunnan, China		MH508852	MH486045	MH485563
A. hiltonii	PERTH06435076	Shire of Harvey, WA	**MT365228–MT365232**			
A. hiltonii	PERTH09004564	Shire of Mundaring, WA	**MT365216–MT365220**	**MT370480**	**MT370479**	**MT370482**
A. hiltonii	PERTH09004580	Shire of Manjimup, WA	**MT365221–MT365227**	**MT370481**		
A. hiltonii	PERTH09004599	Shire of Cuballing, WA				MT370483
A. manginiana	HKAS56933	China		KJ481943	KJ466603	KJ466515
A. miculifera	HKAS101425	Shenyang, China		MH508901	MH486093	MH485609
A. modesta	HKAS79688	China		KJ481944	KJ466604	KJ466516
A. neo-ovoidea	HKAS89025	Yunnan, China		MH508913	MH486106	MH485621
A. preissii	PERTH8690766	Kings Park, WA		KY273109	KY288484	KY273105
A. preissii	PERTH08774781	City of Melville, WA		KY273107		KY273106
A. preissii	PERTH08774773	City of South Perth, WA			KY288485	
A. roseolifolia	HKAS101403	Hainan, China		MH509032	MH486219	MH485723
A. virgineoides	HKAS77278	Hainan, China		MH509166	MH486340	MH485846
A. yenii	HKAS89016	Yunnan, China		MH509172	MH486345	MH485851
A. djarilmari (outgroup)	PERTH08776067	Shire of Cuballing, WA		MF000750	MF000755	MF000742

Table 3. Percentage difference in the internal transcribed spacer (ITS region) within collections and among collections of at least five clones of *Amanita hiltonii collections*.

	No. clones	PERTH09004564	PERTH09004580	PERTH6435076
PERTH09004564	5	0.5–4.7		
PERTH09004580	8	1.0–4.5	0.0–4.2	
PERTH6435076	5	1.4–4.8	0.3–4.7	0.8–4.8

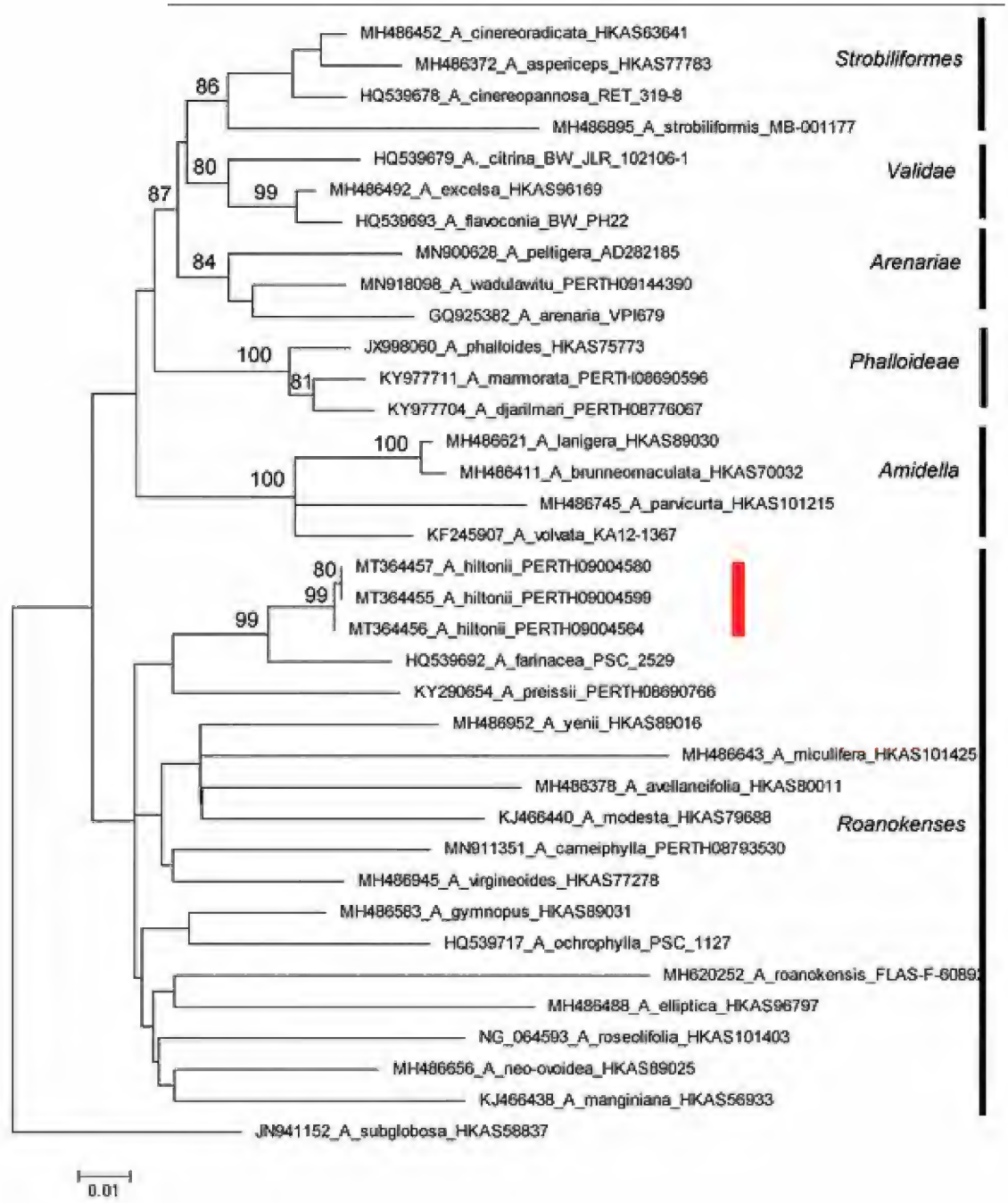


Figure 1. Molecular phylogenetic analysis by the maximum likelihood method of nuLSU sequences (789 base pair positions) from selected species representing all sections in subgenus *Amanitina*. The tree is rooted in *Amanita subglobosa* (subgen, *Amanita* sect. *Amanita)*. Each section is highlighted in black and *A. hiltonii* collections in red.

These phylogenetic trees include *A. carneiphylla* and *A. preissii*, two other species from southern Australia. They show *A. hiltonii* is close to *A. preissii*, a species with a white or pale pileus and very infrequent or no clamp connections. It does not cluster closely with *A. carneiphylla* a species with a white pileus, thick white universal veil, pink lamellae, a rooting stipe and abundant clamp connections.

The ITS region has been used as a barcode marker for species discrimination within the Basidiomycota (Schoch *et al. 2012)*, including *Amanita* sect. *Phalloideae* (Cai *et al.* 2014). Cloned haplotypes of the ITS region, which is between 595 and 604 base pairs long, are available for three *A. hiltonii* collections. Clones within a collection differ by 0.0–4.8%; between collections the difference is up to 4.8% (Table 3). This is greater than for *A. preissii*, where the differences between 23 haplotypes from five collections is 0.16–3.65% (Davison *et al.* 2017), but not as great as for *A. peltigera* where the differences is up to 13.4% (Davison *et al.* 2020).

Taxonomy

Amanita hiltonii D.A.Reid, *Victorian Nat.* 95: 48 (1978)

Mycobank No.: MB 308558

Syn. nov. Amanita albifimbriata O.K.Mill., *Canad. J. Bot.* 69: 2695–2696, (1991) Type: AUSTRALIA, Western Australia, Parkerville, O.K. & H.H. Miller OKM 23729, 28 May 1989, (holo: PERTH02224291!) Mycobank No.: MB 517338.

Type: **AUSTRALIA. Western Australia**, Dale Forest, Brookton Highway, Perth, *D.A. and D.G. Reid and N. Brittan s.n.*, 9 May 1976 (holo: K(M)204139!; iso: DAR32041!).

Small to large fruiting bodies with a white or ivory white pileus. It is initially completely covered by a thick, felted, white to cream universal veil that breaks into low indistinct warts with age. The thick, white ring is superior; it breaks at either mid radius or close to the stipe and remains either attached to the pileus margin or as floccules on the ivory white to cream gills. The stipe

Figure 2a

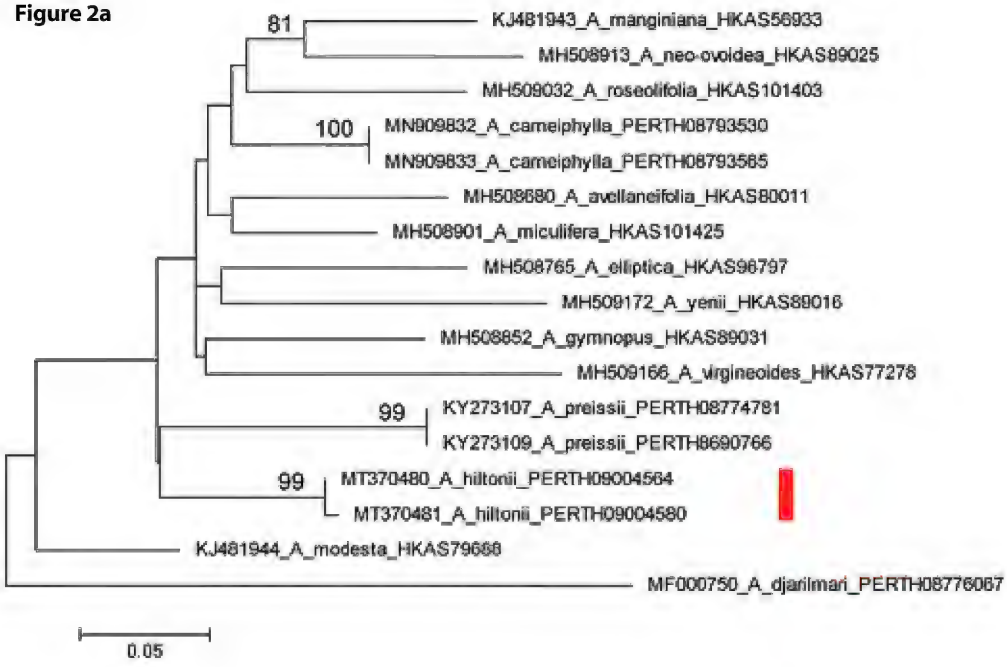


Figure 2. Molecular phylogenetic analysis by the maximum likelihood method of a. *ef1-α sequences (*472 base pair positions), b. *β-tubulin* (204 base pair positions), c. *rpb2* (638 base pair positions) and d. concatenated *β-tubulin ef1-α rpb2* and nuLSU sequences (2012 base pair positions) from selected species in sect. *Roanokenses.* All trees are rooted in *Amanita djarlmari* (sect. *Phalloideae). Amanita hiltonii* collections are highlighted in red.

Figure 2b

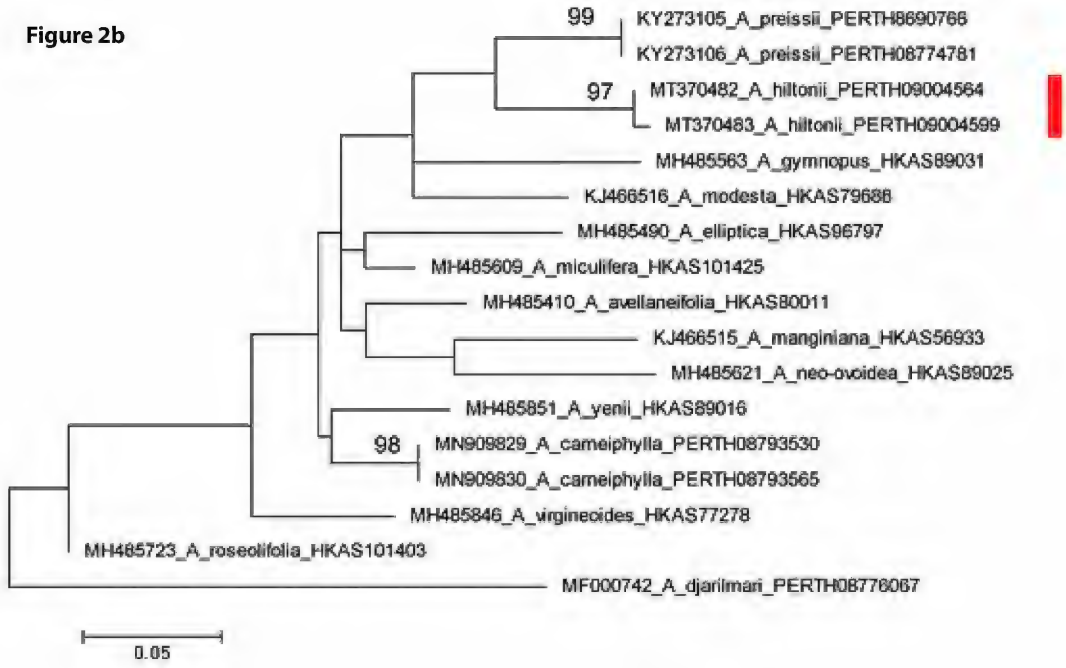


Figure 2c

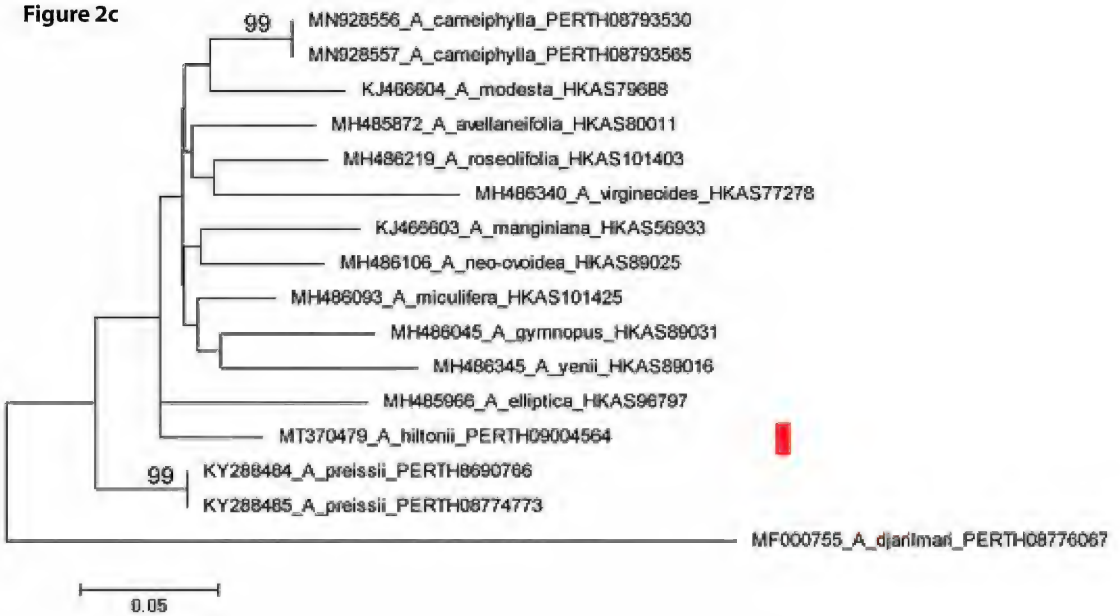
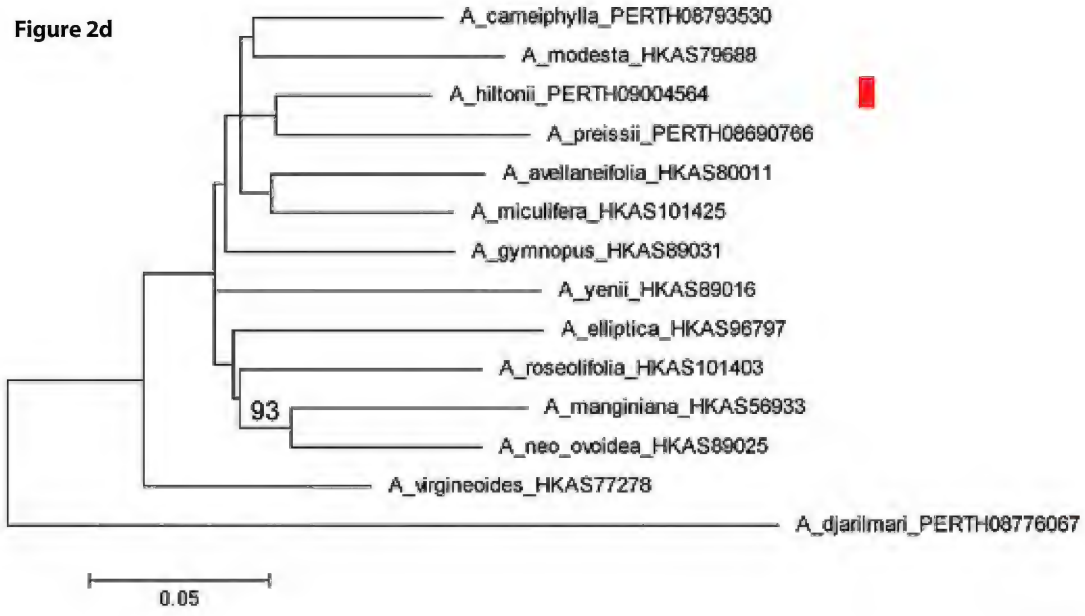


Figure 2d



is densely covered with white to ivory white to cream floccules. The bulb is initially turnip shaped, elongating with age. Old fruiting bodies have a strong, unpleasant smell. The spores are ellipsoid to elongate and amyloid. The universal veil on the pileus has elements with no dominant orientation and is predominantly composed of dominant, terminal inflated cells that are occasionally in chains of two. Clamp connections are present in all tissues.

Pileus 28–115 mm wide, to 18 mm thick, white to ivory white (B), without surface staining or bruising, initially convex becoming plane with depressed centre and decurved margin; margin non-striate, appendiculate with large floccules from partial veil adhering. *Universal veil on pileus* adnate, felted to cottony floccose, as thick crust over whole disc that breaks into low indistinct warts, initially white becoming silvery or ivory white (B) to pale cream (C) to buff (pale 3A2–4B4). *Lamellae* free to adnexed to adnate, close to subcrowded, ivory white (B) to yellowish cream (D) (2A3–3A2), to 16 mm broad, margin pale, fimbriate; *lamellulae* frequent, in several lengths, shortest truncate, longest attenuate. *Stipe* 25–65 mm long, 10–36 mm wide, cylindrical or narrowing downwards, white to ivory white (B) to pale cream (C) (2A3–3A2), surface densely floccose to scurfy with ornamentation white to ivory white (B) to pale cream (C) (2A3–3A2). *Partial* veil superior, thick, breaking at mid radius or close to stipe with remains attached to pileus margin or lamellae, white to ivory white (B) to pale cream (C) (3A2–2A3). *Bulb* 25–65 × 15–35 mm, napiform to turbinate to ovoid to fusiform to carrot shaped. *Remains of universal veil* at top of bulb as easily detached indistinct floccose warts or narrow rim, white. *Pileus and stipe context* white to ivory white (B) to pale cream (C) (2A2–2A3–3A2–4A2), yellowing, stipe solid. *Smell* none to strong and unpleasant with age. *Spore deposit* white becoming pale cream (C) with age (Figure 3).

Basidiospores [380/19/16] (7.5–)8.5–12(–13.5) × (5–)5.5–8(–8.5) µm (**L** = 8.8–12.1 µm; **L'** 10.4 µm; **W** = 5.9–7.5 µm; **W'** 6.7 µm; Q = (1.14–)1.31–1.82(–2.00); **Q** = 1.35–1.71; **Q'** 1.55), colourless, thin walled, smooth, amyloid, broadly ellipsoid or ellipsoid or elongate, contents monogutulate or granular; apiculus sublateral, cylindrical or tapered, *c.* 1 × 1 µm, truncate or rounded. *Pileipellis* not clearly defined in young specimens, to 150 µm thick in old specimens, colourless or very pale yellow in soapy water; filamentous hyphae 2–10 µm wide, colourless, with gelatinising walls, radially orientated with some interweaving; inflated cells not observed; vascular hyphae 2–15 µm wide, pale

Figure 3. *Amanita hiltonii*. Collection showing the appendiculate margin resulting from the partial veil which breaks at mid-radius. Images *E.M. Davison* 31-2013 *& P.J.N Davison*. © E.M. Davison.

yellow to brownish yellow, occasionally branched, very infrequent; clamp connections infrequent. *Pileus context* of dominant or equal filamentous hyphae 2–75 µm wide, with widest constricted at septa, thin-walled, colourless; inflated cells to 220 × 35 µm when clavate, to 700 × 50 µm when ventricose, to 150 × 20 µm when cylindrical, to 70 × 50 µm when ovoid, colourless; vascular hyphae 2–12 µm wide, pale yellow to brownish yellow, occasionally branched, frequent to very infrequent; clamp connections infrequent to frequent. Lamella trama bilateral, divergent. *Central stratum* of thin-walled, colourless, filamentous hyphae 2–15 µm wide; inflated cells not observed; vascular hyphae 3–8 µm wide, colourless to pale yellow, infrequent; clamp connections frequent to infrequent. *Subhymenial base* with angle of divergence 15°–35° from central stratum with filamentous hyphae following smooth broad curve to subhymenium, of dominant thin-walled, colourless, frequently branched filamentous hyphae 2–20 µm wide, widest proximal to subhymenium and constricted at septa; inflated cells infrequent, colourless, to 150 × 25 µm when clavate, to 120 × 20 µm when ventricose, to 150 × 12 µm when cylindrical, to 60 × 25 µm when ovoid; vascular hyphae very infrequent, 2–8 µm wide, pale yellow; clamp connections frequent. *Subhymenium* initially ramose, becoming coralloid or inflated ramose, basidia arising terminally from narrow or barely inflated hyphal segments 4–15 µm wide; clamp connections frequent. *Lamella edge tissue* sterile with frequent to infrequent inflated cells pyriform or clavate or ovoid, 20–45 × 10–20 µm, colourless, disarticulating; clamp connections present. *Basidia* [300/15/15] range: (38–)45–70(–82) × (8–)10–13(–15) µm, thin walled, colourless, c. 88% 4-spored, c. 5% 3-spored, c. 6% 2-spored, c. 1% 1-spored, sterigmata to 7 × 2 µm; clamp connection at base. *Universal veil on pileus* merging into pileipellis in young specimens, layered in some specimens; proximal layer when present very narrow, with periclinal orientation, of dominant filamentous hyphae 3–8 µm wide, colourless, thin walled; inflated cells to 130 × 35 µm when clavate, to 80 × 40 µm when pyriform to 130 × 45 µm when strangulate, to 25 × 12 µm when ellipsoid, colourless, terminal; vascular hyphae 3–8 µm wide, pale yellow, occasionally branched, infrequent; clamp connections present; distal layer very thick, with elements irregularly disposed or somewhat anticlinal; filamentous hyphae 2–15 µm wide, with widest constricted at septa, colourless, gelatinising; inflated cells dominant, to 75 × 75 µm when spherical or sphaeropedunculate, to 75 × 55 µm when ovoid, to 60 × 30 µm when clavate, to 45 × 30 µm when pyriform, to 50 × 30 µm when ellipsoid, terminal or in terminal chains of 2 cells, colourless, gelatinising; vascular hyphae very infrequent to frequent, 2–15 µm wide, colourless or pale yellow, often sinuous; clamp connections frequent. *Universal veil on stipe* base not layered, without clear orientation; filamentous hyphae 2–12 µm wide with widest constricted at septa, colourless, gelatinising; inflated cells dominant or equal, to 75 × 75 µm when spherical, to 70 × 45 µm when ovoid, to 50 × 12 µm when clavate, to 55 × 30 µm when pyriform, to 75 × 50 µm when ellipsoid, terminal or occasionally in terminal chains of 2 cells, colourless, gelatinising; vascular hyphae frequent to infrequent, 2–12 µm wide, colourless or pale greenish yellow; clamp connections frequent. *Stipe context longitudinally* acrophysalidic; filamentous hyphae 3–10 µm wide, colourless; acrophysalides dominant or equal, to 350 µm long × 40 µm wide, clavate, terminal, colourless, gelatinising; vascular hyphae frequent, 3–25 µm, pale yellow to brownish yellow; clamp connections frequent. *Partial veil* of filamentous hyphae 2–10 µm wide, colourless, disarticulating; inflated cells dominant or equal, to 45 × 30 µm when pyriform, to 40 × 15 µm when clavate, to 55 × 40 µm when ovoid, to 30 × 30 µm when spherical or sphaeropedunculate, terminal or occasionally intercalary, colourless, disarticulating, gelatinising; vascular hyphae frequent or infrequent, 2–12 µm wide, pale yellow; clamp connections present (Figure 4).

***Specimens examined*: WESTERN AUSTRALIA.** Shire of Mundaring, 20 July 2011, *E.M. Davison 27*-2011 & *P.J.N Davison* (PERTH09004564, ITS GenBank MT365216–MT365220, nuLSU GenBank MT364456, *ef1-α* GenBank MT370480, *rpb2* GenBank MT370479, *β-tubulin* GenBank MT370482); Shire of Murray, 15 June 2012, *E.M. Davison 21-2012 & P.J.N Davison* (PERTH09004572); Shire of Manjimup, 2 June 2013, *E.M. Davison* 31-2013 *& P.J.N Davison* (PERTH09004580, ITS GenBank MT365221–MT365227, nuLSU GenBank MT364457, ef1-α GenBank MT370481); 11 June 2018, *E.M. Davison* 16-2018 *& P.J.N Davison (*PERTH09004645); Shire of Cuballing, 17 May 2016, *E.M. Davison* 23-2016 *& P.J.N Davison* (PERTH09004599, nuLSU GenBank MT364455, *β-tubulin* GenBank MT370483); Shire of Waroona, 24 June 2017, *E.M. Davison* 45-2017 *& P.J.N*

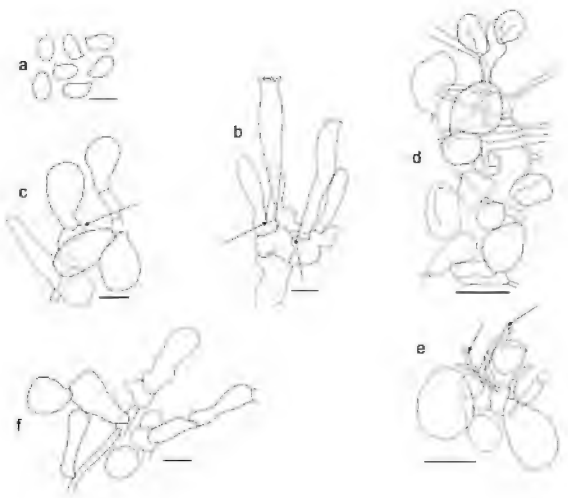


Figure 4. *Amanita hiltonii.* a. spores from lamella; b. squash of basidia and subhymenium, clamp connections indicated with arrows; c. lamella edge cells, clamp connections indicated with arrows; d. section through universal veil on pileus, unsquashed; e. flake from universal veil at base of stipe, unsquashed, clamp connections indicated with arrows; f. ring, squashed. Scale bars 10 µm (a–c, f), 50 µm (d, e). Images from *D.A. and D.G. Reid & N. Brittan s.n.* (K(M) 204139) (a, b, d–f), *E.M. Davison* 27-2011 & *P.J.N Davison* (c).

Davison (PERTH09004602); 25 June 2017, *E.M. Davison* 51-2017 *& P.J.N Davison* (PERTH09004610); Shire of Harvey, 29 May 2003, *R.M. Robinson* FC 360 *R.H. Smith & K. Pearce (*PERTH 6435076 ITS GenBank MT365228–MT365232); Shire of Williams, 22 June 2005, *R.M. Robinson* FC 886 *R.H. Smith & K. Syme* (PERTH06658792); Shire of Denmark, 5 June 2008, *R.M. Robinson* BFF 139 *J. Fielder & K. Syme* (PERTH 06668887); Shire of Nannup, 4 June 2013, *R.M. Robinson* FC 1866 *P. Anderson & S.J.M. McMullan-Fisher* (PERTH08166366); Shire of Denmark, 6 May 1993, *K. Syme* 628/93 (PERTH05485673); Shire of Nannup, 2 June 2007, 2 June 2002, *K. Syme s.n.* (PERTH09004556); Shire of Kalamunda, 16 June 1968, *T Van Quang s.n.* (PERTH 1444808); Shire of Manjimup, 12 Apr 1971, *A. Young s.n.* (PERTH00758868).

Distribution and ecology: Solitary to gregarious in lateritic gravel, red. brown loam and sandy clay in native vegetation. Nearby plants include *Allocasuarina fraseriana, Banksia grandis, Corymbia calophylla, Eucalyptus diversicolor, E. marginata, E. patens, E. rudis, E. wandoo, Gastrolobium biloba, Hibbertia commutata, Macrozamia reidlei* and *Trymalium floribundum*. Occurs in the JAF01, JAF02, Northern and Southern Jarrah Forests, AVW02 Avon Wheatbelt Katanning and WAR01 Warren IBRA subregions (as defined in the Department of the Environment 2013). Fruiting period: April to July.

Notes

As mentioned in the introduction, Miller's macroscopic description of *A. albifimbriata* (Miller 1991) is similar to that of *A. hiltonii* given by Reid (1980) apart from the universal veil on the pileus, and the smell. Miller (1991) describes the universal veil as being 'with easily removed superficial, detersile white warts (2–3 mm wide × 1–2 mm high) clustered over the disc, more scattered towards the margin and missing over the nonstriate margin ..' whilst Reid (1980) described the universal veil as completely covering the pileus which may form low indistinct warts especially towards the centre. From our experience, the pileipellis is initially completely covered by the universal veil but may become exposed with age. Both descriptions differ in their reported odour, which Reid (1980) described as nutty, and Miller (1991) as that of old ham bones or old tennis shoes in all stages of development. Our experience is that this species only develops a strong, unpleasant smell with age.

The most important difference in the descriptions is in relation to the presence of clamp connections. Reid (1980) stated that in *A. hiltonii* the basidia have a basal clamp, whilst Miller (1991) stated that no clamp connections were seen in any tissue of *A. albifimbriata.* However, examination of the type *A. albifimbriata* (PERTH02224291) shows that they are present in all tissues and are frequent at the base of the basidia and in the subhymenium. Other microscopic characters are similar.

There are two additional collections in PERTH that Miller identified as *A. albifimbriata.* One is from the type locality (PERTH02241951, OKM 23799) and the other is from Ludlow (PERTH02241919, OKM 23778) about 200

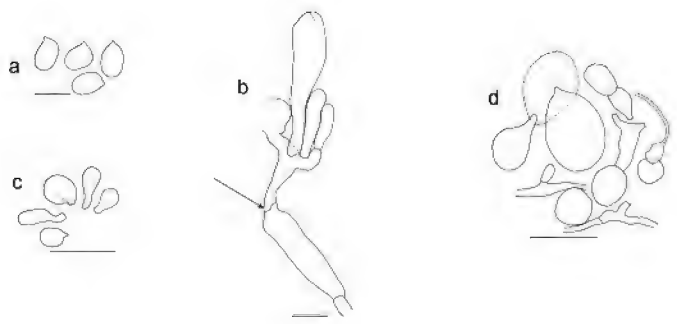


Figure 5. *Amanita albifimbriata*. a. spores from lamella; b. squash of basidium and subhymenium, clamp connection indicated with arrow; c. marginal cells; d. squash of universal veil from pileus. Scale bars = 10 µm (a, b), 50 µm (c, d). Images from *O.K. & H.H. Miller* OKM 23729 type.

km away. Examination of both collections shows that they differ in spore shape, those of PERTH02241951 are ellipsoid to elongate whilst those of PERTH02241919 are elongate to cylindrical. They also differ in the composition of the universal veil on the pileus which is composed of larger inflated cells in PERTH02241919 than in PERTH02241951. Clamp connections are present at the base of basidia in both collections and are frequent in the universal veil of PERTH02241919. On the basis of spore shape, these two collections do not appear to be conspecific; PERTH02241919 does not fit the description of *A. albifimbriata* given by Miller (1991) and characters of the type specimen. It will not be considered further.

The microscopic characters of these two collections of *A. albifimbriata* (PERTH02224291 and PERTH02241951) do not differ from those of *A. hiltonii*. The spores are of similar size and shape (*A. albifimbriata* [60/3/2] 8–12 (–12.5) × (5.5–)6–7.5(–8) µm (**L** 9.0–10.8 µm; **L'** 9.9 µm; **W** 6.8–6.9 µm; **W'** 6.9 µm; Q = (1.14–)1.20–1.71(–1.92); **Q** 1.30–1.60; **Q'** 1.44); *A. hiltonii* [380/19/16] (7.5–)8.5–12(–13.5) × (5–)5.5–8(–8.5) µm (**L** = 8.8–12.1 µm; **L'** 10.4 µm; **W** = 5.9–7.5 µm; **W'** 6.7 µm; Q = (1.14–)1.31–1.82(–2.00); **Q** = 1.35–1.71; **Q'** 1.55). The basidia too are of similar size (*A. albifimbriata* [40/2/2] range (40–)43–64(–67) x (9–)10–14 µm; *A. hiltonii* [300/15/15] range: (38–)45–70(–82) × (8–)10–13(–15) µm) and have a basal clamp connection. The structure of the universal veil is similar (Figure 5).

Attempts to obtain usable DNA from the type of *A. albifimbriata* (PERTH02224291) have not been successful (L.E. McGurk, pers. comm.).

Based on the appearance and microscopic similarities, *A. albifimbriata* is synonymised with *A. hiltonii*.

Amanita kalamundae O.K.Mill., *Canad. J. Bot.* 69: 2697–2698 (1991) [as *A. kalamundi*]

Mycobank No.: MB 560219

Syn. nov. Amanita brunneibulbosa O.K.Mill., *Canad. J. Bot.* 69: 2700, 2702 (1991), Type: AUSTRALIA, Western Australia, Shire of Manjimup, *O.K. & H.H. Miller & N.L Bougher* OKM 23671, 23 May 1989, (holo: PERTH07587457!) Mycobank No.: MB 358173.

Type: **AUSTRALIA.** Western Australia, east of Kalamunda, *B. Dell* OKM 23975, 19 June 1989 (holo: PERTH022242831!).

Notes

As mentioned in the introduction, Miller's macroscopic description of *A. brunneibulbosa* cannot be distinguished from that of *A. kalamundae* when yellow colour changes resulting from aging or bruising are considered (Figure 6).

Examination of Miller's supporting collections (PERTH07547706, OKM 23991, E 683; PERTH07547897, OKM 23988, E 680; PERTH07548001, OKM 23866, E 609), showed clamp connections are present in the lamellae of PERTH07547897; they could not be determined in PERTH07547706 because the material

Figure 6. *Amanita kalamundae.* Showing yellow bruising and discolouration on and in the stipe (arrows). Image from *O.K. and H.H. Miller* OKM 23988 © N.L. Bougher.

is in poor condition. Collection PERTH07548001 fits the description of *A. peltigera* D.A. Reid, with a small, white volval limb, broadly ellipsoid spores, universal veil on the pileus composed of dominant filamentous hyphae and frequent large inflated cells, and no clamp connections. This collection will not be considered further.

The microanatomy is similar. The basidiospores are amyloid, and of similar size: *A. kalamundae* [180/7/6] (7.5–)8.5–12.5(–13.5) × 5–7.5(–9) µm (**L** = 8.9–11.1 µm; **L'** 10.1 µm; **W** = 5.4–6.9 µm; **W'** 6.4 µm; Q = (1.30–)1.36–1.91(–2.20); **Q** = 1.44–1.87; **Q'** 1.61) (McGurk *et al.* 2016), *A. brunneibulbosa* [60/3/3] (8.5–)9–12(–12.5) × (5–)5.5–7(–7.5) µm (**L** = 9.4–11.6 µm; **L'** 10.3 µm; **W** = 5.9–6.8 µm; **W'** 6.3 µm; Q = (1.31–)1.50–1.83(–1.85); **Q** = 1.56–1.71; **Q'** 1.65). Clamp connections are present in the subhymenium and at the base of some basidia.

The unique features used by Miller (1991) are the brown pileus with detersile white patches of universal veil, white floccose partial veil, small oval bulb, ovoid to short elliptical amyloid spores and absence of clamp connections, to distinguish *A. brunneibulbosa* from other species are not supported by a more detailed examination of the holotype and his other named collections. These characters are shared by *A. kalamundae*. On this basis, *A. brunneibulbosa* is synonymised with *A. kalamundae*.

Acknowledgements

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Muelleria

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ROYAL BOTANIC GARDENS VICTORIA

Comparison of modern classifications for filmy ferns (Hymenophyllaceae) and a new combination in *Trichomanes* L. for the filmy fern *Macroglena brassii* Croxall, from Queensland, Australia

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Introduction

The filmy ferns (Hymenophyllaceae) are a distinctive group of leptosporangiate ferns distinguished by a thin membranous lamina that is usually one cell thick (or occasionally up to four cells thick in some parts of the lamina) and marginal sori that are protected by an indusium in the form of a cup-shaped or bilabiate involucre (Ebihara *et al.* 2007). Forty nine species of this family occur in Australia, of which 15 are probably endemic (Green 1994; Bostock & Spokes 1998; Ebihara & Iwatsuki 2007). Two major lineages exist within the Hymenophyllaceae that largely correspond to the two original genera recognised within the family: *Hymenophyllum* Sm. and *Trichomanes* L. (Pryer *et al.* 2001; Hennequin *et al.* 2003; Ebihara *et al.* 2004). Numerous other classifications have been proposed that recognise several additional genera (e.g. Copeland 1938, 1947; Morton 1968; Pichi Sermolli 1977; Iwatsuki 1984) and some have been adopted in key treatments of the Australian Hymenophyllaceae. The classification used by Tindale (1963), Croxall (1975) and Andrews (1990) is most similar to the classification proposed by Copeland (1938, 1947), which recognised 16 genera in Australia. It differed from that of Copeland (1938, 1947) by some genera being recognised as subgenera of *Hymenophyllum*, while *Vandenboschia* Copel. and *Crepidopteris* Copel were included in *Trichomanes* and *Reediella* Pichi-Sermolli respectively due to concerns that *Vandenboschia* Copel.

Abstract

Contemporary Hymenophyllaceae treatments typically follow one of two classifications that recognise monophyletic genera. One comprises nine genera, while the other recognises two genera, *Hymenophyllum* Sm. and *Trichomanes* L. Combinations exist for all Australian species that allow the former classification to be adopted in Australia. However, genera of the former classification tend to be poorly defined morphologically compared to the latter classification. All Australian species have available combinations in either *Hymenophyllum* or *Trichomanes* except for one Queensland species originally described as *Macroglena brassii* Croxall. A new combination in *Trichomanes* is made here for *M. brassii* so that the two genus classification of Hymenophyllaceae can be followed in Australia.

Keywords: *Abrodictyum, Trichomanes brassii*, generic limits.

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and *Crepidopteris* Copel. were illegitimate, which is indeed the case for *Crepidopteris*. The Flora of Australia treatments by Du Puy & Orchard (1993), Green (1994) and Bostock & Spokes (1998) followed the classification of Iwatsuki (1984), which recognised five genera in Australia.

Genera recognised in these morphologically-based classifications have been shown to be non-monophyletic by recent phylogenetic analyses of chloroplast DNA sequence data (Hennequin *et al.* 2003, 2006, 2010; Ebihara *et al.* 2004, 2007). A more recent classification proposed by Ebihara *et al.* (2006) and followed by PPG I (2016) differed from previous classifications by including some species in *Hymenophyllum* that were once included in or previously thought to be closely related to *Trichomanes* (e.g. *Cardiomanes* C.Presl, *Microtrichomanes* (Mett.) Copel. in part and *Pleuromanes* C.Presl), and by recircumscription of some genera in the *Trichomanes* lineage. This made all Hymenophyllaceae genera monophyletic according to molecular phylogenetic analyses (Pryer *et al.* 2001; Hennequin *et al.* 2003, 2006, 2010; Ebihara *et al.* 2004). The names for all Australian Hymenophyllaceae species under this Ebihara *et al.* (2006) classification are provided by Field (2020).

While some contemporary treatments follow this classification (e.g. Smith *et al.* 2006; Jiaxi *et al.* 2013), assigning some species to these genera using morphological features without an underlying knowledge of their phylogenetic placement is virtually impossible (Brownsey & Perrie 2016). This is because some of these genera lack morphological features that are shared by all species or, when they are unified by a common feature, these features are also present in species of other genera (Ebihara *et al.* 2007; Brownsey & Perrie 2016). The close morphological resemblance that can exist between some of these narrowly circumscribed genera is epitomised by *Trichomanes cupressoides* Desv. from the tropical islands of the Indian Ocean. *Trichomanes cupressoides* was shown by phylogenetic analyses of chloroplast *rbcL* to harbour two cryptic species that belonged to separate genera (*Abrodictyum* C.Presl and *Trichomanes s.s.*) under the Ebihara *et al.* (2006) classification (Bauret *et al.* 2015).

The recent practice adopted by PPG I (2016) of segregating several smaller genera from large genera that can be both morphologically defined and monophyletic, as with *Trichomanes s.l.*, has been criticised by Christenhusz & Chase (2018). They discuss the impracticality for identification and the nomenclatural instability such splitting creates, and criticise the inconsistencies in generic concepts adopted by PPG I (2016) in retaining some large genera such as *Asplenium* L., while splitting other similarly large complex genera into several segregates. PPG I (2016) justified recognising these segregate genera because they were monophyletic and they had been previously recognised with available names. However, in the case of the Hymenophyllaceae the limits of pre-existing genera had been altered drastically to retain monophyly within the family and hardly resembled their original concepts. Consequently, Christenhusz & Chase (2018) stated that "PPG I (2016) should not be viewed automatically as the necessary and logical next step in fern classification".

For Hymenophyllaceae, an alternative classification that also recognises monophyletic genera but avoids the issues highlighted by Christenhusz & Chase (2018) is to recognise only *Hymenophyllum* and *Trichomanes*, which are slightly altered from their traditional circumscription to correspond to the two major lineages in Hymenophyllaceae. This classification is currently used in New Zealand (Brownsey & Perrie 2016). The main limitation to this classification is that it groups together several older lineages in *Trichomanes* that have divergence times that are more typically observed in ferns between genera or even families (Schuettpelz & Pryer 2006). However, the genera are much better defined morphologically under this classification, with *Trichomanes* having densely hairy rhizomes, compared to glabrous or sparsely hairy rhizomes in *Hymenophyllum*. Some features are also only present in many *Trichomanes* or *Hymenophyllum* that instantly allow those species to be placed into one or other genus. These include false-veins and erect rhizomes present in several *Trichomanes* species but absent in *Hymenophyllum* (with the exception of New Zealand *H. pulcherrimum* Colenso that has erect rhizomes) and toothed lamina margins in *Hymenophyllum* that are absent in *Trichomanes* (Morton 1968). The author here advocates the use of this two genus classification in Australia in preference to the classification of Ebihara *et al.* (2006) because of the ease of morphological

Figure 1. *Trichomanes brassii* plant at Herberton Range, northeast Queensland. Photo: Peter Richardson.

recognition of its genera compared to some of the genera of the latter classification.

Almost all of the Australian Hymenophyllaceae species have combinations in *Hymenophyllum* and *Trichomanes* because they were described prior to classifications that recognised several genera in addition to *Hymenophyllum* and *Trichomanes*. The one exception is the Queensland endemic *Macroglena brassii* Croxall (Figure 1). This belongs to a group of *Trichomanes* species, recognised as *Abrodictyum* C.Presl by Ebihara *et al.* (2006), that also includes the Australian species *T. caudatum* Brack. and *T. obscurum* Blume (Ebihara *et al.* 2007). Among Australian species, *M. brassii* is morphologically most similar to *T. obscurum*, which also has an erect rhizome and highly dissected fronds. *Macroglena brassii* can be distinguished from *T. obscurum* by its linear and bristle-like ultimate segments (Bostock & Spokes 1998). The ultimate segments are also narrow (only one or two rows of cells bordering the axes) and bristle-like in Malesian *T. pluma* Hook. and New Caledonian *T. laetum* Bosch. These species are more closely related to other *Trichomanes* (*Abrodictyum*) species than they are to *M. brassii* (Ebihara *et al.* 2007) and can be distinguished by fronds with a 3-dimensional arrangement rather than being primarily planar. A new combination in *Trichomanes* is made here for *M. brassii* so that the two genus classification of Hymenophyllaceae can be followed in Australia.

Taxonomy

Trichomanes brassii (Croxall) D.J.Ohlsen, *comb. nov.*

Macroglena brassii Croxall, *Austral. J. Bot.* 23: 543 (1975); *Cephalomanes brassii* (Croxall) Bostock, *Fl. Australia* 48: 706 (1998); *Abrodictyum brassii* (Croxall) Ebihara & K.Iwats., *Blumea* 51(2): 243 (2006). Type: Mount Finnegan, west slopes, Qld, 6 Sept. 1948, *L.J.Brass 20048*; holo: BRI AQ0024748 (image!); iso: CANB 184593 (image!), K 001090238 (image!).

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Muelleria

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ROYAL BOTANIC GARDENS VICTORIA

Studies in *Podolepis* and some related genera (Asteraceae: Gnaphalieae)

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Introduction

Podolepis Labill. was described in 1806, the type species being *P. rugata* Labill. *Panaetia* Cass. and *Siemssenia* Steetz were described in 1829 and 1845 respectively, the type species being *Panaetia lessonii* Cass. and *Siemssenia capillaris* Steetz. Bentham (1866) placed the former in *Podolepis* and made the new combination *Podolepis lessonii* (Cass.) Benth., and Diels (1904) placed the latter in *Podolepis* and made the new combination *Podolepis capillaris* (Steetz) Diels.

Davis (1957) revised *Podolepis,* which included the descriptions of 18 species as well as a detailed taxonomic and nomenclatural history of the genus up to that time. During that history, a rather disparate assemblage of taxa, whose only common feature is the presence of scarious involucral bracts, had been regarded as belonging to *Podolepis.* Some of these taxa have been removed to other genera, e.g. *Podolepis georgei* Diels to *Schoenia* Steetz (as *Schoenia ayersii* (F.Muell.) J.M.Black – *see* Black 1915) and *Podolepis tetrachaeta* (Schltdl.) Walp. to *Leptorhynchos* Less. (as *Leptorhynchos tetrachaetus* (Schltdl.) J.M.Black – *see* Black 1921)

Chromosome numbers were obtained for many *Podolepis* species by Turner (1967), ranging from *n*=3 to *n*=12, including an anomalous value of *n=ca.* 30 for *Podolepis jaceoides* (Sims) Voss (*see* Jeanes 2015a). Turner (1967) commented that, "... such a complicated array of chromosome numbers in *Podolepis* was unanticipated ...", but he nevertheless considered the genus to be, "... except for *P. lessonii* ... quite natural." In their study of fruit anatomy of members of the Australian Inuleae, Short *et al.* (1989) stated that "...*Podolepis* is clearly an unnatural genus." This comment was based on differences in floret types, bract morphology, chromosome numbers and fruit morphology within the genus. Furthermore Short *et al.* (1989) suggested that *Panaetia* and *Siemssenia* should be reinstated

Abstract

The genera *Panaetia* Cass. and *Siemssenia* Steetz are reinstated and the new combinations *Panaetia davisiana* (D.A.Cooke) Jeanes, *Panaetia tepperi* (F.Muell.) Jeanes and *Siemssenia microcephala* (Benth.) Jeanes are created. The new genus *Walshia* Jeanes is created to accommodate the anomalous taxon previously known as *Helipterum kendallii* F.Muell. and *Podolepis kendallii* (F.Muell.) F.Muell., and the new combination *Walshia kendallii* (F.Muell.) Jeanes is made. Taxonomic treatments are given for *Podolepis arachnoidea* (Hook.) Druce, *P. gardneri* G.L.Davis, *P. gracilis* Graham, *P. hieracioides* F.Muell., *P. longipedata* A.Cunn. ex DC., *P. monticola* R.F.J.Hend. and *P. nutans* Steetz, seven species not covered in three recent papers on the genus *Podolepis* (Jeanes 2015a, Jeanes 2015b, Frood 2015). The new combination *Coronidium gnaphalioides* (Domin) Jeanes is created to accommodate the taxon previously known as *Podolepis gnaphalioides* Domin.

Keywords: morphology, taxonomy, *Walshia*

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and that *P. georgei* and *Podolepis kendallii* (F.Muell.) F.Muell. should be removed from *Podolepis*. Anderberg (1991) agreed that, based on general morphology, floret morphology and other features, *Podolepis* was probably polyphyletic. A study based on molecular systematics (Konishi *et al.* 2000) would also suggest that *Panaetia* and *Siemssenia* are sister to *Podolepis* and could be recognised at some level.

In a previous paper (Jeanes 2015a), *Podolepis s.str.* was defined and a key to 18 of the species described at that time presented – with the exception of *P. gardneri* G.L.Davis, inadvertently overlooked for that work. A further species in *Podolepis s.str.* has been described since then (Jeanes 2015b). *Podolepis* currently consists of *ca.* 20 species and several subspecific taxa. Given the combined evidence of general morphology, floret morphology, chromosome numbers and molecular data, it appears that reinstatement of *Panaetia* and *Siemssenia* at generic level is warranted (see Table 1 for the main distinguishing characters of genera covered in this paper).

Podolepis kendallii is an unusual member of the Gnaphalieae by virtue of its distinctive fruit (long-papillose) and pappus (bristles distinctly plumose at the apex) morphology (Konishi *et al.* 2000). The various consensus trees derived by Konishi *et al.* (2000) show *P. kendallii* grouping with *Waitzia* J.C.Wendl., which otherwise has "...little similarity in fruit morphology and other morphological characteristics" (Konishi *et. al.* 2000). Other authors (e.g. Short *et al.* 1989, Watanabe *et al.* 1999) commented about the uniqueness of *P. kendallii* and suggested its removal from *Podolepis*. The distinctive and unique morphology of *P. kendallii* suggests that its placement in a monotypic genus is warranted and the genus *Walshia* Jeanes is created here to accommodate it.

Materials and Methods

Examination of qualitative and quantitative characters were made from dried herbarium specimens held at AD, BRI, CANB, DNA, HO, NT, PERTH and, particularly, MEL (herbarium codes follow Thiers 2020). All the relevant type specimens held at MEL have been examined and those from other herbaria were either examined directly or accessed and examined through JSTOR Global Plants (JSTOR 2000–2018). The measurements given in the descriptions were taken from dried specimens and may differ slightly from the dimensions of living plants. The distribution maps were downloaded from the Australasian Virtual Herbarium website (AVH 2018).

Taxonomy

Panaetia Cass., *Ann. Sci. Nat. (Paris)* 17: 417 (1829)

Type species: *Panaetia lessonii* Cass.

Annual *herbs*, glabrous or somewhat arachnose. *Stems* 1–several, erect, usually branched. *Leaves* entire; basal leaves (when present) petiolate, apex acute; cauline leaves alternate, sessile, base amplexicaul, stem-clasping, decurrent, apex acute. *Peduncles*

Table 1: Main characters distinguishing *Panaetia*, *Podolepis*, *Siemssenia* and *Walshia*.

	Panaetia	*Podolepis*	*Siemssenia*	*Walshia*
Habitat	Arid regions	Arid and more mesic regions	Arid regions	Arid regions
Habit	Annual herbs	Annual and perennial herbs	Annual herbs	Annual herbs
Peduncles	Naked	With leafy bracts (naked in *P. gardneri*)	Naked	With leafy bracts
Outer florets	Tubular	With a 3–5-toothed ligule-like limb	With a 3–4-toothed ligule-like limb	Tubular
Number of pappus bristles on female florets	0–10 (female florets absent from *P. davisiana*)	6–40	0	0
Cypselas	Minutely papillose	Minutely papillose	Minutely papillose	Covered with long finger-like papillae
Chromosome number (n)	7 or 8	9–12	3 or 11	11

Key to genera dealt with in this paper.

1 Outer florets each with a ligule-like limb, prominent and far exceeding the involucres in most species, but small and barely exceeding the involucres in some species 2

1: Outer florets all tubular 4

2 Ligule-like limbs on outer florets prominent and much exceeding the involucres, usually wholly yellow or with some white, pink or purplish colouration ..... ***Podolepis***

2: Ligule-like limbs on outer florets barely exceeding the involucres, mostly white, sometimes yellow, lacking any pink or purplish colouration 3

3 Involucral bract lamina narrow-elliptic, prominently wrinkled transversely; outer involucral bracts passing into stem leaves with no obvious peduncle present; stems few-branched, thick ..... ***Podolepis***

3: Involucral bract lamina oblong, indented on both sides about half way along, more or less smooth; outer involucral bracts not passing into stem leaves with the capitula on an obvious leaf-free peduncle; stems much-branched, wiry ..... ***Siemssenia***

4 Cypselas covered with long finger-like papillae ..... ***Walshia***

4: Cypselas minutely tuberculate and lacking long finger-like papillae ..... ***Panaetia***

filiform, naked. *Inflorescences* 1–many per plant. *Capitula* hemispherical or campanulate, disciform or discoid, solitary or few arranged in loose corymbose panicles. *Involucral bracts* free, united at the very base or in basal half, few–many-seriate, with slender linear claws, unequal, lamina scarious, margins fringed or entire. *Florets* yellow; outer florets female (bisexual in *P. davisiana*), uniseriate, tubular; disc florets bisexual, numerous, tubular. *Cypselas* terete, minutely papillose; pappus bristles few, plumose.

Figure 1. Cypsela, floret and pappus bristles of *Walshia kendallii* from MEL 2027936. Reproduced with permission from Royal Botanic Gardens Victoria.

Panaetia lessonii Cass., *Ann. Sci. Nat. (Paris)* 17: 417 (1829)

Podolepis lessonii (Cass.) Benth., *Fl. austral.* 3: 606 (1867); *Podolepis lessoni* (Cass.) Benth. *Fl. austral.* 3: 606 (1867) *nom illeg.* (orth. var. of *Podolepis lessonii*); *Podolepis lessoni sensu* G.L.Davis. *Proc. Linn. Soc. New South Wales* 81: 270 (1957) *nom illeg.* (orth. var. of *Podolepis lessonii*). ***Type:*** **WESTERN AUSTRALIA.** 'Cette plante habite aussi les environs du port du Roi-Georges, où elle a été recueille en 1826 par M. Lesson. Nous l'avons décrite sur des échantillons appurtenant à M. Mérat.' (This plant is found in the neighbourhood of the Port of King George, where it was collected in 1826 by M. Lesson. We have described it on specimens belonging to M. Mérat.): Nouv. Holl. port du roi Georges, reçuen 1833 M.Merat, no collection date, *M.Lesson s.n.* (Isotype GDC G00461476 photo! JSTOR Global Plants).

Podolepis gilbertii Turcz., *Bull. Soc. Imp. Naturalistes Moscou* 24 (1): 195 (1851); *Podolepis gilberti* Turcz., *Bull. Soc. Imp. Naturalistes Moscou* 24 (1): 195 (1851) *nom. illeg.* (orth. var. of *Podolepis gilbertii*). ***Type*****: WESTERN**

Key to species of *Panaetia*.

1 Innermost involucral bracts united for about half their length to form a rigid cup enclosing the florets ..... ***P. muelleri***

1: Innermost involucral bracts not as above **2**

2 Florets all similar, bisexual, fertile; innermost involucral bracts united at the base ..... ***P. davisiana***

2: Florets dissimilar; outer florets long-tubular and female, inner florets tubular, bisexual; innermost involucral bracts free to the base **3**

3 Involucral bracts with fringed margins, shallowly wrinkled, pale; Western Australia only ..... ***P. lessonii***

3: Involucral bracts entire, glabrous, shiny; Western Australia, South Australia and Victoria ..... ***P. tepperi***

Figure 2. Representative specimen of *Panaetia lessonii* (MEL 2027600). Reproduced with permission from Royal Botanic Gardens Victoria.

AUSTRALIA. 'Nova Hollandia occidentalis. Gilbert coll. n. 269 *et* 282': Western Australia, 1842, *Gilbert 269 and 282* (Syntypes KW 001001499 and KW 001001498 photos!).

Illustrations: Davis (1957) Figs 92–100 (as *Podolepis lessoni*); Grieve and Blackall (1975) page 790; Western Australian Herbarium (2018) (both as *Podolepis lessonii*).

Annual *herb* to 40 cm tall. *Stems* 1–several, erect, usually branched, sparsely woolly below. *Leaves* woolly below, sparsely septate-hairy above, margins, entire; basal leaves (when present) usually oblanceolate, 3–4.5 cm long and 1–1.5 cm wide, petiolate, apex acute; cauline leaves alternate, sessile, base amplexicaul, stem-clasping, decurrent, usually lanceolate, 1–7 cm long and 2–15 mm wide, apex acute. *Peduncles* filiform, 5–10 cm long, naked. *Inflorescences* 1–80 per plant. *Capitula* campanulate, mostly 6–12 mm diam., usually solitary or few arranged in loose panicles. *Involucral bracts* free, many-seriate, with slender linear claws, unequal, lamina scarious, pale, semi-transparent, shallowly wrinkled, margins fringed; intermediate bracts 4–5 mm long, lamina triangular, apex acute, claw slender; inner bracts with claw longer than lamina. *Florets* yellow; outer florets female, uniseriate, 8–16, tubular, 3- or 4-toothed, with a single pappus bristle; disc florets bisexual, numerous, 4- or 5-toothed, with 3 or 4 pappus bristles. *Cypselas* terete, c. 1 mm long, c. 0.4 mm wide, minutely papillose; pappus bristles plumose distally (Figure 2).

***Selected specimens examined*: WESTERN AUSTRALIA**. Bruce Rock, Pikaring Hill Reserve, 18.viii.2013, *G. Byrne 4650* (MEL 2410612); 37 km N of Yanchep on Lancelin Road, 10.ix.1975, *M.L. Clark 188* (MEL 597751); Kalbarri National Park, at 'The Loop', 19.x.1983, *P.S. Short 2127* (MEL 1523492); Harrismith, 0.5 km E of township, 26.ix.1979, *J. Taylor 895* (MEL 1619231); 37 km N of Yanchep on Lancelin Road, 10.ix.1975, *M.L. Clark 188* (MEL 597751).

Distribution and habitat: Endemic to Western Australia where widespread in the South-West and Eremaean Provinces, scattered over *ca.* 14 IBRA7 Regions (Commonwealth of Australia 2012). Found in a wide variety of habitats and soils (Figure 16a)

Conservation status: Widespread, common and well represented in conservation reserves.

Flowering period: Mostly August to January.

Cytology: Chromosome number determinations of *n*=7, 2*n*=14 were reported by Turner (1967) and Watanabe *et al.* (1999) under the name *Podolepis lessonii*.

Notes: The holotype of *Panaetia lessonii* does not appear in JSTOR Global Plants, nor apparently is it in the historical collections in Paris (P).

The type sheet of *Podolepis gilbertii* consists of seven elements (all apparently of the same taxon) and four labels. Two of the labels refer to the two syntypes Gilbert 269 (KW 001001499) and Gilbert 282 (KW 001001498), and one label refers to a Drummond collection (KW 001001500), which is not a type. There is no apparent link between the specimens and the labels so determining which of the specimens are the types is not possible.

A specimen at Geneva (G00301420) is annotated as an isotype of *P. gilbertii*, but this is a Drummond collection and hence cannot be type material. Without seeing the type sheet, Davis (1957) concluded that *P. gilbertii* was most likely synonymous with *Podolepis lessonii* (= *Panaetia lessonii*) and this appears to be correct.

Panaetia davisiana (D.A.Cooke) Jeanes, ***comb. nov.***

***Basionym*:** *Podolepis davisiana* D.A.Cooke, *J. Adelaide Bot. Gard.* 7(3): 281, fig. 4 (1985). ***Type:* SOUTH AUSTRALIA.** Western edge of Lake Torrens, c. 3 km N of South Gap Station Homestead, 3.ix.1968, *R. Swinburne 19* (holotype, AD 96929450!, isotype, MEL 674081! (Figure 3)).

Illustrations: Cooke (1985) Figure 4; Jessop and Toelken (1986) Figure 710C (both as *Podolepis davisiana*).

Annual *herb* to 16 cm tall. *Stems* 1–several, erect, sparsely branched, sparsely arachnose mostly at the nodes. *Leaves* lanate below, arachnose to lanate above, margins entire; basal leaves (when present) usually elliptic to oblanceolate, 1–4 cm long and 0.5–1.5 cm wide, petiolate, apex acute; cauline leaves alternate, sessile, amplexicaul at base, decurrent, lanceolate to elliptic, 1–4 cm long and 2–10 mm wide, apex acute. *Peduncles* filiform, 1–6 cm long, naked. *Inflorescences* 1–20 per plant. Capitula hemispherical, homogamous, discoid, mostly 8–10 mm diam., usually solitary or few arranged in loose panicles. *Involucral bracts* about 6-seriate, with short linear claws, unequal, lamina scarious, stramineous, smooth or shallowly wrinkled, margins almost entire to fringed; intermediate bracts free, 4–5 mm long, lamina ovate, margins fringed, apex acute, claw slender; inner bracts united at base. *Florets* yellow; 40–90, all bisexual, tubular, 5-toothed. *Cypselas* ellipsoid, slightly compressed, c. 1.5 mm long, c. 0.4 mm wide, sparsely and minutely papillose; pappus bristles 9–14, subplumose.

Figure 3. Isotype of *Podolepis davisiana* (MEL 674081) = *Panaetia davisiana.* Reproduced with permission from Royal Botanic Gardens Victoria.

***Specimens examined*: SOUTH AUSTRALIA**. 5 miles (*ca.* 8 km) N of Duff Creek, 7.viii.1963, *T.R.N. Lothian 1354* (MEL 1594430); Woomera, 1 km from Woomera on Pimba road, 27.x.1989, *B. Nordenstam, A. Anderberg 834* (MEL 1591043); 3 km S of Pimba, 14.x.1995, *K. Watanabe 325* (MEL 2027397); 3 km S of Pimba on Stuart Highway, 16.x.1996, *K. Watanabe 691,T. Denda & N. Konishi* (MEL 2034803).

Distribution and habitat: Endemic to South Australia where scattered over seven IBRA7 Regions (Commonwealth of Australia 2012). Mostly found on stony slopes and gibber plains (Cooke 1985). (Figure 16b)

Conservation status: Widespread and represented in conservation reserves.

Flowering period: Mostly August and September.

Cytology: Chromosome number determinations of n=7 and $2n$=14 were reported by Watanabe et al. (1999) under the name *Podolepis davisiana*.

Notes: *Panaetia davisiana* is unique in the genus in having all florets similar and bisexual. Apparently all records of *P. lessonii* for South Australia are referrable to either *P. davisiana* or *P. muelleri*.

Panaetia muelleri Sond., *Linnaea* 25: 505 (1852)

Podolepis muelleri (Sond.) G.L.Davis, *Proc. Linn. Soc. New South Wales* 81: 272 (1957). ***Type:* SOUTH AUSTRALIA.** 'Inter rivum Crystalbrook et sinum Spencer, Oct.' (Between Crystalbrook and Spencers Gulf, October): x.1851, *F.Mueller s.n.* (lectotype, MEL 305652 part A! (Figure 4) *fide* G.L. Davis (1957), isolectotypes, MEL 305652! Part B, MEL 305653!).

Podolepis lessonii auct. non (Cass.) Benth., *Fl. austral.*, 3: 606 (1866) *p.p.* as to eastern Australian specimens.

Podolepis cupulata Maiden & Betche, *Proc. Linn. Soc. New South Wales* 38(2): 249 (1913). ***Type:* NEW SOUTH WALES.** 'Wanganella, near Hay (Miss Edith Officer; October, 1903)': Wanganella, near Hay, x.1903, *Miss Edith Officer s.n.* (lectotype here designated, NSW 25443 photo! JSTOR Global Plants; isolectotypes, MEL 2280348!, BRI-AQ 0354839 photo! JSTOR Global Plants, AD 97225107 photo! JSTOR Global Plants, K 000899354 photo! JSTOR Global Plants).

Illustrations: Davis (1957) Figs 101–109; Cunningham *et. al* (1992) page 663; PlantNET (2018) (all as *Podolepis muelleri*).

Annual *herb* to 22 cm tall. *Stems* 1–several, wiry, erect or ascending, sparsely branched, sparsely arachnose to glabrescent. *Leaves* arachnose, margins entire; basal leaves (when present) usually elliptic to oblanceolate, 1–5 cm long and 0.5–1 cm wide, petiolate, apex acute; cauline leaves alternate, sessile, amplexicaul at base, decurrent, lanceolate, 1–4 cm long and 2–8 mm wide, apex acute. *Peduncles* filiform, erect, 1–4 cm long, naked. *Inflorescences* 1–70 per plant. *Capitula* hemispherical to campanulate, heterogamous, disciform, mostly 3–7 mm diam., usually solitary or few arranged in loose panicles. *Involucral bracts* about 6-seriate, with short linear claws, unequal, lamina scarious, shiny, stramineous, often bluish distally, smooth; intermediate bracts 3.5–4 mm long, lamina broad-ovate, margins minutely erose-ciliate, apex acute, claw slender, glandular; inner bracts with broad, thickened oblong claws adhering for c. half their length to form a cup around the florets, becoming cartilaginous with small triangular scarious laminae. *Florets* yellow, tubular, slightly exceeding the involucre; outer florets 3–7, female, slightly asymmetric, 3- or 4-toothed; inner florets 18–40, bisexual, 5-toothed. *Cypselas* terete, c. 1.5 mm long, c. 0.4 mm wide, sparsely and minutely papillose; pappus bristles absent from female florets, up to 13 on bisexual florets, shortly plumose, shortly connate at base.

***Selected specimens examined*: SOUTH AUSTRALIA.** Northern areas, ix.1890, *W. Gill, 170* (MEL 0716833!); Port Augusta, 1887, *L.T. Wehl s.n.* (MEL 716843). **QUEENSLAND.** 0.8 km E of Yelarbon Post Office, 8.ix.2001, *Bean, A.R. 17788* (MEL 2166258). **NEW SOUTH WALES.** Talluba Creek, 17.5 km ENE of Pilliga on the Wee Waa road, 8.ix.1986, *J.M.Dalby 86/55* (MEL 1576230); Western side of Red Bobs Reserve, about 40 km south west of Gunnedah, 25.ix.2005, *J.R. Hosking 2619* (MEL 2361495). **VICTORIA**. Eastern side of Lake Tyrrell on a raised northerly projecting promontory onto the lake bed, beside Storers Road, 7.x.2014, *J.A.Jeanes 3099* (MEL 2379586).

Distribution and habitat: Widespread in South Australia and New South Wales, but rare in Queensland and Victoria, and scattered over *ca.* 13 IBRA7 Regions (Commonwealth of Australia 2012). Grows on coastal cliffs to deep inland in woodland, grassland and saltbush shrubland on heavy soils often on stony sites (PlantNET). (Figure 16c)

Conservation status: Widespread and represented in conservation reserves.

Flowering period: Mostly August to November.

Cytology: Chromosome number determination of

Figure 4. Lectotype and isolectotypes of *Panaetia muelleri* (MEL 305652). Reproduced with permission from Royal Botanic Gardens Victoria.

n=7, was reported by Watanabe *et al.* (1999) under the name *Podolepis muelleri*.

Note: The herbarium sheet containing the lectotype (MEL 305652) consists of six main elements and some fragments. The right hand element (A) was designated by G.L. Davis as the lectotype and the remaining elements (B) as isolectotypes (termed lectoparatypes by Davis).

Panaetia tepperi (F.Muell.) Jeanes, ***comb. nov.***

Basionym: *Helichrysum tepperi* F.Muell., *S. Sci. Rec.* 2: 1 (1882); *Podolepis tepperi* (F.Muell.) D.A.Cooke, *J. Adelaide Bot. Gard.* 7(3): 284 (1985). ***Type:*** **SOUTH AUSTRALIA.** 'In Yorke's Peninsula; O. Tepper.': South Australia, Muloowurtie, 28.ix.1880, *J.G.O. Tepper 79* (lectotype here designated, MEL 727577! (Figure 5)); Yorkes Peninsula, South Australia, no date, *O. Tepper s.n.* (possible isolectotype, K000978224, photo! JSTOR Global Plants).

Illustrations: VicFlora (2018); PlantNET (2018) (both as *Podolepis tepperi*).

Annual *herb* to 15 cm tall. *Stems* 1–several, erect to ascending, few-branched, glabrous to slightly arachnose. *Leaves* arachnose, usually more densely so below, margins entire; basal leaves in a distinct rosette, usually elliptic, 0.5–2 cm long, to c. 10 mm wide, petiolate, apex acute; cauline leaves alternate, sessile, amplexicaul, decurrent, usually lanceolate, 0.5–2 cm long, to c. 7 mm wide, apex acute. *Peduncles* filiform, 1–4 cm long, naked. *Inflorescences* 1–10 per plant. *Capitula* campanulate, mostly 3–5 mm diam., disciform, usually solitary or few arranged in loose panicles. *Involucral bracts* few-seriate, with slender linear claws, unequal, lamina scarious, blue-green tinted, shiny, semi-transparent, smooth, margins entire; intermediate bracts free, 3–4 mm long, lamina ovate, apex acute, claw c. equal to lamina; inner bracts scarious-hyaline, linear, slightly connate at base. *Florets* all tubular, pale yellow, shorter than involucre; outer florets 10–20, female, filiform, 3- or 4-toothed; inner florets bisexual, 10–25, 4- or 5-toothed. *Cypselas* terete, 0.5–1 mm long, c. 0.4 mm wide, minutely papillose; pappus bristles 5–10, free, 2–3 mm long, minutely barbellate.

***Selected specimens examined*:** **WESTERN AUSTRALIA**. Cowcowing, 1.viii.1904, *M. Koch 1076* (MEL 696716, MEL 696720); 26 miles S of Norseman, 12.ix.1965, *B.L. Turner 5560* (MEL 602403). **SOUTH AUSTRALIA.** Lower slopes of Wilpena Pound, 1.x.1996, *R.J. Bates 44655* (MEL 2373910); Hundred of Coombe 6.5 km ENE of Tintinara, 1.x.1991, *P.J. Lang D-8231* (MEL 2373533). **VICTORIA.** Ellam Flora Reserve, 18.ix.1986, *A.C. Beauglehole s.n.* (MEL 2337620); Bronzewing Flora and Fauna Reserve along southern boundary track, 11.x.2014, *V. Stajsic 7602* (MEL 2392419).

Distribution and habitat: Widespread and often locally common in the South-West Province of Western Australia, southern South Australia, north-eastern Victoria, and apparently rare in south-western New South Wales. Scattered across *ca.* 13 IBRA7 Regions (Commonwealth of Australia 2012). Usually occurs in mallee communities, margins of salt lakes or woodlands on sandy, loamy or clay soils (Western Australian Herbarium 1998–). (Figure 16d)

Conservation status: Widespread, common and well represented in conservation reserves.

Flowering period: Mostly August to October

Cytology: A chromosome number determination of *n*=8 was reported by Watanabe *et al*. (1999) under the name *Podolepis tepperi*.

Podolepis Labill., *Nov. Holl. Pl.* 2: 56, t.208 (1806) (*nom. cons.*)

Scalia Sieber ex Sims *Bot. Mag.* 24: t. 956 (1806)

Stylolepis Lehm. *Sem. hort. bot. Hamburg* 14, 17 (1828)

Scaliopsis Walp. *Linnaea* 318 (1840)

Rutidochlamys Sond. *Linnaea* 25: 497 (1852)

Rhytidochlamys Anderb. (orth. var. of *Rutidochlamys*) *Opera Bot.* 104: 120 (1991)

Type species: *Podolepis rugata* Labill. *Nov. Holl. Pl.* 2: 57, t.208 (1806)

Annual or perennial *herbs*, often with arachnose eglandular or glandular hairs. *Stems* 1–several, erect, usually branched. *Leaves* entire; basal leaves (when present) sessile, apex acute; cauline leaves alternate, sessile, base amplexicaul, stem-clasping, often decurrent, apex acute. *Peduncles* elongate with leafy bracts decreasing in size towards the involucres (naked and filiform in *P. gardneri*). *Inflorescences* 1–many per plant. *Capitula hemispherical or campanulate,* solitary or several loosely clustered together at the end of branches. *Involucral bracts* free, many-seriate, each with a linear claw-like stereome, or sometimes the lamina of bract at least partially continuous with stereome, unequal, lamina scarious, margins entire. *Florets* yellow,

Figure 5. Lectotype of *Helichrysum tepperi* (MEL 727577) = *Panaetia tepperi*. Reproduced with permission from Royal Botanic Gardens Victoria.

Key to species of *Podolepis*

1 Scarious part of intermediate involucral bracts at least partially continuous with the stereome **2**

1: Scarious part of intermediate involucral bracts completely discrete from the claw-like stereome **5**

2 Outer involucral bracts not passing into stem leaves; peduncles naked and filiform ..... ***P. gardneri***

2: Outer involucral bracts passing into stem leaves with no obvious peduncle present **3**

3 Ray florets barely exceeding length of involucral bracts; lamina of involucral bracts deeply transversely rugose ..... ***P. arachnoidea***

3: Ray florets far exceeding length of involucral bracts; lamina of involucral bracts smooth (sometimes slightly wrinkled in dry specimens) **4**

4 Intermediate involucral bracts 9–14 mm long; lamina of intermediate involucral bracts oblong, apex acute to obtuse ..... ***P. neglecta*#**

4: Intermediate involucral bracts 5–8 mm long; lamina of intermediate involucral bracts ovate to triangular, apex acuminate ..... ***P. omissa*#**

5 Lamina of intermediate involucral bracts transversely rugose at least towards the apex **6**

5: Lamina of intermediate involucral bracts virtually smooth (sometimes slightly wrinkled in dry specimens) **8**

6 Lamina of intermediate involucral bracts often shorter than their claw, lamina 1–2.5 mm long; capitula <10 mm diam ..... ***P. canescens****

6: Lamina of intermediate involucral bracts about as long as or longer than their claws, lamina usually 2.5–10 mm long; capitula usually >10 mm diam. except rarely in depauperate specimens **7**

7 Apex of involucral bracts more or less obtuse; capitula mostly 20–30 mm diam.; plant perennial ..... ***P. rugata****

7: Apex of involucral bracts acute to aristate; capitula mostly 10–20 mm diam.; plant annual ..... ***P. aristata****

8 Apex of lamina of intermediate involucral bracts acute to aristate **9**

8: Apex of lamina of intermediate involucral bracts retuse to obtuse **18**

9 Lamina of intermediate involucral bracts shorter than their claws **10**

9: Lamina of intermediate involucral bracts as long as or longer than their claws **12**

10 Lamina of intermediate involucral bracts narrow-trullate, less than twice as wide as their claws ..... ***P. rugata****

10: Lamina of intermediate involucral bracts ovate or ± triangular, more than twice as wide as their claws **11**

11 Lamina of intermediate involucral bracts ovate-acuminate, more or less flat (sometimes slightly wrinkled in dry specimens); Western Australia, Northern Territory and South Australia ..... ***P. eremaea****

11: Lamina of intermediate involucral bracts ± triangular, usually with an adaxial bowl-like depression just above junction with the claw; South Australia, north-eastern New South Wales and Queensland ..... ***P. longipedata***

12 Ray florets pink or mostly yellow but apically tinged purple **13**

12: Ray florets only yellow **14**

13 Ray florets pink; lamina of intermediate involucral bracts ovate, longer than broad, straw coloured, transparent, scarious ..... ***P. gracilis***

13: Ray florets yellow, tinged with purple at the apex; lamina of intermediate involucral bracts transverse-elliptic, broader than long, reddish-brown, not transparent, rigid ..... ***P. nutans***

14 Capitula mostly 5–10(–15) mm diam.; laminas of intermediate involucral bracts mostly 2–3(–4) mm long; plants from dry inland habitats **15**

14: Capitula mostly (10–)15–30 mm diam.; laminas of intermediate involucral bracts mostly >4 mm long; plants from various habitats **16**

15 Involucral bracts closely imbricate, hiding the claws; lamina of intermediate involucral bracts broad ovate to sub-orbicular, somewhat concavo-convex, often nearly as wide as long ..... ***P. remota****

15: Involucral bracts loosely imbricate, not hiding the claws; lamina of intermediate involucral bracts ovate, more or less flat (sometimes slightly wrinkled in dry specimens), much narrower than long ..... ***P. eremaea****

16 Capitula mostly 10–20 mm diam.; plants annual; southern half of Australia ..... ***P. aristata****

16: Capitula mostly 20–30 mm diam.; plants perennial; eastern Australia **17**

17 Basal leaves linear, mostly 3–6 mm wide, glabrous or nearly so; apex of involucral bracts usually long-acuminate to aristate; mostly grasslands ..... ***P. linearifolia****

17: Basal leaves usually lanceolate to oblanceolate, rarely linear, mostly 5–20 mm wide, variously hairy; apex of involucral bracts acute to acuminate; various habitats ..... ***P. jaceoides****

Key to species of *Podolepis* (continued)

18 Involucral bracts closely imbricate, hiding the claws, somewhat concavo-convex; small annuals from north-west and central Australia ..... ***P. remota****

18: Involucral bracts loosely imbricate, not hiding the claws, more or less flat (sometimes slightly wrinkled in dry specimens); robust perennials from southern and eastern Australia **19**

19 Lamina of intermediate involucral bracts shorter than their claws; capitula usually 3–20 in terminal clusters .. ***P. hieracioides***

19: Lamina of intermediate involucral bracts similar in length or longer than their claws; capitula solitary or few in loose or contracted panicles **20**

20 Basal and cauline leaves linear; plants ± glabrous or glabrescent except for prominent axillary hair tufts on basal leaves ..... ***P. laevigata****

20: Basal and cauline leaves not linear; plants variously hairy **21**

21 Basal leaves to 20 mm wide; stems often several; capitula usually solitary, or rarely a few in loose panicles; slender plants mostly of lowland habitats but extending into the alps ..... ***P. decipiens****

21: Basal leaves mostly 15–65 mm wide; stem usually solitary; capitula usually 5–11 in a dense contracted panicle; robust plants of montane to alpine habitats **22**

22 Basal leaves woolly to glabrescent, ovate to obovate, 35–65 mm wide, petioles winged; from mountainous areas of north-eastern New South Wales and south-eastern Queensland ..... ***P. monticola***

22: Basal leaves glabrous or hairy, but not woolly, oblong to spathulate, mostly 15–35 mm wide, petioles not markedly winged; alpine and subalpine areas of south-eastern New South Wales and Victoria **23**

23 Ray florets yellow to orange, 9–13 mm long, teeth to 2 mm long; claw of involucral bracts c. 1 mm wide; capitula 15–25 mm diam.; mature cypselas<3 mm long ..... ***P. robusta***§

23: Ray florets yellow, 14–20 mm long, teeth 2–4.5 mm long; claw of involucral bracts 1.5–2 mm wide; capitula 25–30 mm diam.; mature cypselas 3–4.5 mm long ..... ***P. laciniata***§

For taxonomic and nomenclatural information on species marked "*" in the above key *see* Jeanes 2015a; for those marked "#", *see* Jeanes 2015b; and for those marked "§", *see* Frood 2015.

white or purplish; ray florets female, uniseriate, with a 3–5-toothed, ligule-like limb usually much exceeding the involucres (except in *P. arachnoidea*); disc florets bisexual, numerous, tubular, deeply 5-lobed. *Cypselas* terete, minutely papillose; pappus bristles numerous, barbellate to shortly plumose, basally connate or free.

Podolepis arachnoidea (Hook.) Druce, *Rep. Bot. Exch. Club Brit. Isles, Suppl. 2*: 640 (1917)

Basionym*: *Rutidosis arachnoidea Hook., in T.Mitchell, *J. exped. trop. Australia* 341 (1848). ***Type:* QUEENSLAND.** '6th October...the camp of the Pyramids...included an ascent of Mount Pluto...a new RUTIDOSIS, a tall herbaceous perennial [***R. ARACHNOIDEA (Hook. MS.)]': Sub-Tropical New Holland, 1846, *T.L. Mitchell s.n.* (holotype, K 000899332, photo! JSTOR Global Plants); Queensland. Camp near the Pyramids, 7.x.1846, *T.L. Mitchell s.n.* (probable isotype, MEL 241720! (Figure 6)); Queensland. Near the Pyramids, Nov-Holl. inter subtrop., 7.x.1846, *T.L. Mitchell s.n.* (probable isotype, MEL 696384!).

Rutidochlamys mitchellii Sond., *Linnaea* 25: 497 (1852) *nom. illeg.* (*Rutidosis arachnoidea* cited in synonymy).

Podolepis rhytidochlamys F.Muell., *Fragm.* 4 (26): 79 (1864) *nom. illeg.* (*Rutidosus arachnoidea* cited in synonymy);

Podolepis rutidoclamys F.Muell. in Benth., *Fl. austral.* 3: 603 (1867) *nom. illeg.* (orth. var. of *Podolepis rhytidochlamys*)

Illustrations: Davis (1957) Figs 126–133; Cunningham *et. al* (1992) page 665; VicFlora (2018), PlantNET (2018).

Perennial *herb* to 80 cm tall. *Stems* 1–many, erect, usually branched, woolly to glabrescent. *Leaves* woolly on both surfaces or just below, margins entire; basal leaves usually oblanceolate, 3–13 cm long and 1–2 cm wide, petiolate, apex acute; cauline leaves alternate, sessile, stem-clasping, decurrent, usually narrow-lanceolate, 1–11 cm long and 3–20 mm wide, apex acuminate. *Peduncles* to c. 5 mm long. *Inflorescences* 1–many per plant. *Capitula* campanulate, mostly 5–10 mm diam., usually 3–10 loosely clustered together at the end of branches. *Involucral bracts* unequal, narrow-elliptic, acuminate, scarious, wrinkled, glabrous, shiny; intermediate bracts 5–10 mm long, short-clawed; inner bracts green with scarious margins, short-clawed. *Florets* yellow; ray florets 5–7, female, uniseriate, with

Figure 6. Probable isotype of *Rutidosis arachnoidea* (MEL 241720) = *Podolepis arachnoidea*. Reproduced with permission from Royal Botanic Gardens Victoria.

a ligule-like limb c. 2.5 mm long, 3–4-lobed, barely exceeding the involucre; disc florets bisexual, usually 10–15. *Cypselas* terete, 2–3 mm long, c. 0.5 mm wide, minutely papillose; pappus bristles 25–30, free, minutely barbellate.

***Selected specimens examined*: NORTHERN TERRITORY.** Port Darwin, 1888, *M.W. Holtze 910* (MEL 716213). **QUEENSLAND.** State Forest 341, Wondul Range Stock Route, 6.x.1999, *P.I. Forster 24943* (MEL 298791); 59 km E of Barcaldine on road to Jericho, 15.x.1993, *B.J. Lepschi 1171* (MEL 2067770). **NEW SOUTH WALES.** 20 km E of Goolgowi, 23.ix.1973, *E.J. McBarron 20838* (MEL 571975); Cocoparra Range, Woolshed Flat area beside tributary of Woolshed Creek, 16.xi.1988, *N.G. Walsh 2217* (MEL 295436).

Distribution and habitat: Widespread mostly in Queensland and New South Wales, scattered over about 20 IBRA7 Regions (Commonwealth of Australia 2012). Three old collections from the Northern Territory (Port Darwin), South Australia (Coopers Creek) and Victoria (Kulkyne/Australia Felix) respectively are of uncertain provenance. Found mostly in mallee scrub and woodland on sandy soils (PlantNET 2018). (Figure 16e)

Conservation status: Widespread, common and well represented in conservation reserves.

Flowering period: September to February.

Cytology: Chromosome number determinations of *n*=9 were reported by Turner (1967) and Watanabe *et al.* (1999).

Notes: In his published journal, Mitchell (1848) indicated that he did no collecting on 7 October 1846, so the dates on the probable MEL isotypes are here considered to be in error.

Podolepis gardneri G.L.Davis, *Proc. Linn. Soc. New South Wales* 81: 264 (1957)

***Type:* WESTERN AUSTRALIA.** Meekatharra, Western Australia, Quartz rises, rays yellow, 20.vii.1931, *C.A. Gardner 2358* (holotype, PERTH 1182455, photo! JSTOR Global Plants).

Illustrations: Davis (1957) Figs 50–57; Grieve and Blackall (1975) page 791; Corrick and Fuhrer (1996) Fig 43.

Annual *herb* 15–30 cm tall. *Stems* 1–many, erect, usually branched, almost glabrous. *Leaves* with short septate hairs on both surfaces, margins entire; basal leaves usually oblanceolate, 2–7 cm long and 2–5 mm wide, petiolate, apex obtuse; cauline leaves alternate, sessile, stem-clasping, decurrent, usually broad-linear, 1–7 cm long and 2–5 mm wide, apex obtuse. *Peduncles* naked, to c. 5 cm long. *Inflorescences* 1–20 per plant. *Capitula* campanulate, mostly 9–15 mm diam., usually solitary or few clustered together at ends of branches. *Involucral bracts* unequal, rhomboidal or oblanceolate to ovate, sub-acute to acute, scarious, smooth or slightly wrinkled, glabrous; intermediate bracts 5–8 mm long, short-clawed, the stereome continuing about half way along lamina; inner bracts subsessile. *Florets* yellow; ray florets 25–30, female, uniseriate, with a ligule-like limb 9–11 mm long, 2-lobed with a third lobe arising from the base of the limb; disc florets bisexual, many. *Cypselas* terete, 2–3 mm long, c. 0.5 mm wide, minutely papillose; pappus bristles c. 15, free, minutely barbellate (Figure 7).

***Selected specimens examined*: WESTERN AUSTRALIA**. 1 km NNE of Retreat Bore, Koonmarra Station, 29.viii.1986, *R.J. Cranfield 6008* (CANB 489863.1); Sandstone-Leonora road, 147 miles by road ESE of Sandstone, 63 miles by road SE of Agnew, 14.ix.1966, *R.V. Smith 66/494* (MEL 1516335); Upper Murchison River, 1892, *I. Tyson 72* (MEL 716229); 24 km E of Dalgety Downs H.S., this is 105 km E of Gascoyne Junction, 31.vii.1969, *P.G. Wilson 8483* (CANB 354952.1).

Distribution and habitat: Endemic to Western Australia where widespread across inland parts of the state, scattered over 5 IBRA7 Regions (Commonwealth of Australia 2012). Found on rocky outcrops, on hillsides and creek beds (Western Australian Herbarium (1998–). (Figure 16f)

Conservation status: Widespread, common and well represented in conservation reserves.

Flowering period: July to October.

Cytology: Chromosome number determination of *n*=8 was reported by Turner (1967).

Podolepis gracilis Graham, *Edinburgh New Philos. J.* 5: 379 (1828); Steetz, *Pl. Preiss* 1(3): 463 (1845)

***Type:* CULTIVATED.** 'The seeds of this plant were sent to us from New South Wales in November last by Mr Fraser, as a species of *Centaurea*. The plants have been kept in the greenhouse of the Royal Botanic Gardens, and will produce very few seeds': no locality, i.vii.1828, no collector (holotype, E 00417433, photo! JSTOR Global Plants).

Stylolepis gracilis Lehm., *Sem. hort. bot. Hamburg* 14: 17 (1828). ***Type*: CULTIVATED.** 'Hab. in Nova Hollandia. Semina ex Anglia sub nominee Centaurea especiei accepimus.' (Habitat in New Holland. Seeds from England

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MEL1555314
NATIONAL HERBARIUM OF VICTORIA (MEL)
podolepis gardneri Lewis
Family: Compositae
Loc.: WESTERN AUSTRALIA - 40 km north of Coolgardie Junction.
Lat. 30°41'S; Long. 119°19'E. Alt:
Coll: F.G. Short 3824, with R.S. Sander & N.A. Palmer.
Det.
Notes: Major area erect.
All florets yellow.
Rocky outcrop with Acacia and Eremophila shrubs.
Depl: RD, CANB, PERTH.
NATIONAL HERBARIUM OF VICTORIA (MEL), AUSTRALIA

Figure 7. Representative specimen of *Podolepis gardneri* (MEL 1555314). Reproduced with permission from Royal Botanic Gardens Victoria.

sent [to Hamburg] under the name of *Centaurea* sp.): hort. Bot. Hamburg 1834 (ex herb. Sonder), no collection date, no collector (lectotype here designated, MEL 715994, photo!).

Stylolepis gracilis Lehm. var. *glabra* Lehm. *Sem. hort. bot. Hamburg* 14: 17 (1828). *Type*: (not cited).

Stylolepis gracilis Lehm. var. *arachnoidea* Lehm. *Sem. hort. bot. Hamburg* 14: 17 (1828). *Type*: (not cited).

Podolepis filiformis Steetz. *Pl. Preiss.* 1(3): 465 (1845). ***Type*: WESTERN AUSTRALIA.** 'In turfosis humidis inter frutices ad lacum prope Woodman's-point. d. 18. Dec. 1838. Herb. Preiss. No. 57.' (In moist peat amongst shrubs beside a/the lake near Woodman's Point.): Swan River in Nova Holland[ia]. [Woodman Point], no date, *J.A.L. Preiss 57* (lectotype here designated, MEL 2280265!, isolectotype, MEL 715992!); 18.xii.1838, *J.A.L.Preiss 57* (isolectotypes, LD 180112343, photo! JSTOR Global Plants, MEL 2280264!); no locality, no date, *J.A.L. Preiss 57* (probable isolectotype, W 0046599, photo! JSTOR Global Plants).

Podolepis rosea Steetz *Pl. Preiss.* 1(3): 463 (1845). ***Type*: WESTERN AUSTRALIA.** 'In arenosis sylvae prope Limekilns, d. 23. Sept. 1839. Herb. Preiss. No. 55.' (In sandy woods near Limekilns): no date, *J.A.L. Preiss 55* (lectotype *fide* G.L. Davis (1957), MEL 2280274 part A!, isolectotypes MEL 2280274 part B!, MEL 715991!, MEL 715995!, LD 1800547, photo! JSTOR Global Plants, S S-G-4946, photo! JSTOR Global Plants, possible isolectotype, W 0046596, photo! JSTOR Global Plants).

Podolepis rosea Steetz var. *mollissima* Steetz *Pl. Preiss.* 1(3): 464 (1845). ***Type*: WESTERN AUSTRALIA.** 'In arenosis subumbrosis secundum flavium Cygnorum supra oppidulum Perth, d. 3. Aug. 1839. Herb. Preiss. No. 53. et in colliculis calcareis haud procul ad oppidulo Freemantle, d. 15 Aug. 1839. No. 61. In terra Leuwin, in collibus aridis. Ferd. Bauer! (V.s. in herb. Aulico Vindobonn!).' (In rather shady, sandy places by the Swan River upstream of the township of Perth (Preiss 53), and in little calcareous hills not far at all from the township of Freemantle (Preiss 61). In Leeuwins land in arid hills (Bauer). Seen in Vienna herbarium): Sandy rather shady places on the Swan R., above Perth, 3.viii.1839, *J.A.L. Preiss 53* (lectotype *fide* G.L. Davis (1957), MEL 2280275 part A!, isolectotypes, MEL 2280275 part B!, MEL 2165149!; LD 1800611, photo! JSTOR Global Plants, W 18890130448 & W 18890105670, photos! JSTOR Global Plants, possible isolectotypes, W 0046598, photo! JSTOR Global Plants, BR 0000005429547, photo! JSTOR Global Plants). In colliculis calcareis haud procul ab urbiscula 'Freemantle', 15.viii.1839, *J.A.L. Preiss 61* (syntype, LD 1800675, photo! JSTOR Global Plants). Nova Hollandia ora australis, Lewins Land [Cape Leeuwin] in collibus aridis, no date, *F.L. Bauer s.n.* (syntype, W 0046597, photo! JSTOR Global Plants).

Podolepis rosea Steetz var. *mollissima* Walp. *Repert. bot. syst.* 6(2): 236 (1846) *nom. illeg. non* Steetz (1845)

Podolepis gracilis (Lehm.) Graham f. *alba* Voss *Vilm. Blumengärtn.* edn. 3, 1(1): 537 (1894). *Type*: (not cited).

Podolepis gracilis (Lehm.) Graham f. *rosea* (Steetz) Voss *Vilm. Blumengärtn.* edn. 3, 1(1): 537 (1894). Basionym: *Podolepis rosea* Steetz.

Podolepis gracilis (Lehm.) Graham f. *superba* Voss *Vilm. Blumengärtn.* edn. 3, 1(1): 537 (1894). *Type*: (not cited).

Podolepis spenceri Ewart *Proc. Roy. Soc. Victoria* 20(1): 83, t. xiii (1907). ***Type*: WESTERN AUSTRALIA.** 'Woorooloo (=Wooroloo), W.A., M. Koch, 1906': Wooroloo, x.1906, *M. Koch 1509* (lectotype here designated, MEL 2280276!, isolectotypes, MEL 715993!, PERTH 01182919!, PERTH 01182927!, BM 000810530, photo! JSTOR Global Plants).

Illustrations: Davis (1957) Figs 75–83; Grieve and Blackall (1975) page 792; Western Australian Herbarium (2018).

Annual *herb* to 50 cm tall. *Stems* 1–many, erect, usually branched, sparsely woolly to glabrescent. *Leaves* sparsely woolly below, more or less glabrous above, margins entire; basal leaves seldom present; cauline leaves alternate, sessile, stem-clasping, decurrent, usually oblanceolate to broad-linear, 1–8 cm long and 3–15 mm wide, apex acute to acuminate. *Peduncles* to c. 10 cm long. *Inflorescences* 1–many per plant. *Capitula* campanulate, mostly 1–2 cm diam., solitary or few clustered together at ends of branches. *Involucral bracts* unequal, triangular to ovate, straw-coloured, acute to subacute, scarious, smooth, glabrous, shiny; intermediate bracts 4–7 mm long, lamina longer than broad, with slender glandular claws about equal in length to lamina; inner bracts scarious, short-clawed. *Ray florets* pink fading to white, 15–40, female, uniseriate, with a ligule-like limb 10–15 mm long, 2–3-lobed. *Disc florets* pink fading to white, sometimes yellow, bisexual, numerous. *Cypselas* terete, 1–1.5 mm long, c. 0.5 mm wide, minutely papillose; pappus bristles 6–20, free, minutely barbellate (Figure 8).

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NATIONAL HERBARIUM OF VICTORIA (MEL)
MELBOURNE, AUSTRALIA
MEL 2028029
319 ASTERACEAE
Podolepis gracilis Graham
Coll: P.S. Short 4551 Date: 3 Nov 1995
Addit. Coll.: N. Wamsley, K. Kemp and T. Doyle
AUSTRALIA : WESTERN AUSTRALIA
4551
NATIONAL HERBARIUM OF VICTORIA (MEL), AUSTRALIA

Figure 8. Representative specimen of *Podolepis gracilis* (MEL 2028029). Reproduced with permission from Royal Botanic Gardens Victoria.

***Selected specimens examined*: WESTERN AUSTRALIA**. 15.5 km E of Jurien on road to Brand Highway, 15.xi.1983, *L. Haegi 2669* (MEL 663833); Whistlepipe Gully Kalamunda, 19 km E of Perth, 3.ix.1984, *R. Hamilton & M. Hamilton 17* (MEL 1527891); About 7 km by road W of Augusta, 1.xi.1983, *P.S. Short 2256* (MEL 1523018); By Calgardup, c. 12 km SW of Margaret River, 16.xi.1982, *A. Strid 21386* (MEL 627974).

Distribution and habitat: Endemic to Western Australia where widespread and common, mostly in the South-West Province, and scattered over seven IBRA7 Regions (Commonwealth of Australia 2012). Found on sandy or gravelly soils over limestone, granite or laterite as well as on coastal limestone and winter-wet flats (Western Australian Herbarium 1998–). (Figure 17a)

Conservation status: Widespread, common and well represented in conservation reserves.

Flowering period: August to January.

Cytology: Chromosome number determination of *n*=12 was reported by Turner (1967) and Watanabe *et al.* (1999).

Notes: *Podolepis gracilis* and *Stylolepis gracilis* were described in the same year. Steetz (1845) gives priority to *P. gracilis* and there appears to be no reason to dispute this.

The lectotype specimen of *Podolepis rosea* var. *mollissima* as designated by Davis (1957) is mounted on the sheet MEL 2280275. This sheet appears to be a mixed collection consisting of three main components arranged from left to right across the sheet. Two fragment pockets labelled [Preiss] no. 61 and [Preiss] no. 53 are also present. The two outer components (MEL 2280275 part B) appear to be part of the same gathering and are at a later stage of maturation than the central component (MEL 2280275 part A). In 1956 G.L. Davis placed a determination slip partially behind and below the central component, clearly designating it as the lectotype of *Podolepis rosea* var. *mollissima*. Below this central component is also an old label with "53" written on it as well as an original label in Steetz's hand stating that the collection was made along the Swan River near Perth. The two outer components (MEL 2280275 part B) are most likely an isolectotype.

Podolepis hieracioides F.Muell., *Fragm.* 1(5): 112 (1859)

***Type:* VICTORIA.** 'In vallibus graminosis juxta ripas fluminum Delatite, McAllister River, Mitta Mitta, Omeo Creek, Snowy River Alibique, altitudine 2–4000.' (In grassy valleys beside the banks of the rivers Delatite, McAllister, Mitta Mitta, Omeo Creek and elsewhere, altitude 2–4000 ft.): Victoria. Macallister (= McAllister) River, i.1859, *F. Muell. s.n.* (lectotype *fide* J.H. Willis 1954, MEL 716192! (Figure 9); isolectotype, MEL 716193!). Victoria. Ad ripas graminosas fluminus Delatite & ejusden tribular, 26.iii.1853, *F. Muell. s.n.* (syntype, MEL 716195!); Victoria. Delatite, no date, *F. Muell. s.n.* (syntype, MEL 716194!); Victoria. Delatite, 1853, *F. Muell. s.n.* (syntype, K 000899334 photo! JSTOR Global Plants).

Podolepis hieracioides F.Muell. *First Gen. Rep. Gov. Bot. Veg. Colony* 14 (1853) *nom. inval., nom. nud.*

Illustrations: Davis (1957) Figs 25–32; VicFlora (2018); PlantNET (2018).

Perennial *herb* to 70 cm tall. *Stems* 1–several, erect, simple or few-branched, woolly to glabrescent. *Leaves* scabrous to glabrescent, margins entire; basal leaves lanceolate to elliptical, 5–20 cm long, 1–2.5 cm wide, stem-clasping at base, apex acute; cauline leaves alternate, sessile, stem-clasping, decurrent, usually linear to narrow-lanceolate, mostly 5–13 cm long and 3–15 mm wide, decreasing in size up the stem, apex acute to acuminate. *Peduncles* 1–5 cm long. *Inflorescences* 1–several per plant. *Capitula* hemispherical, mostly 1.5–2 cm diam., 3–20 arranged in short, dense, terminal panicles. *Involucral bracts* unequal, ovate, obtuse to subacute, scarious, smooth, glabrous, shiny; intermediate bracts 5–9 mm long, with broad glandular claws usually longer than lamina; inner bracts scarious, long-clawed. *Ray florets* yellow, 15–30, female, uniseriate, with a ligule-like limb 10–18 mm long, 2–4-lobed. *Disc florets* yellow, bisexual, numerous. *Cypselas* terete, 1.5–3 mm long, c. 1 mm wide, minutely papillose; pappus bristles 30–40, shortly connate at base, minutely barbellate.

***Selected specimens examined*: QUEENSLAND**. Bald Mountain railway enclosure near Wallangarra, 13.i.1933, *S.T Blake 4458* (BRI AQ 0270146); Toowoomba, ix.1921, *R.J. Holdsworth s.n.* (BRI AQ 0270148). **NEW SOUTH WALES**. Breakfast Creek on the Pikes Saddle – Damper Trig Road, c. 40 km E of Bredbo, 1.iii.1975, *R.G. Coveny 6234* (MEL 2165825); Snowy River. 0.5 km NW from Sawpit on Waterfall Track, 9.ii.1996, *M. Ito 96057* (MEL 2030508). **VICTORIA**. Mt Seldom Seen, 0.5 km S of summit, 6.ii.1980, *S.J. Forbes 197* (MEL 574720); Between upper Cann and Genoa Rivers, almost on the NSW border, 13.i.1953, *R. Melville 2865* (MEL 716199).

Distribution and habitat: Widespread and sometimes

Figure 9. Lectotype of *Podolepis hieracioides* (MEL 716192). Reproduced with permission from Royal Botanic Gardens Victoria.

Figure 10. Lectotype of *Podolepis longipedata* (MEL 2280269). Reproduced with permission from Royal Botanic Gardens Victoria.

locally common from south-eastern Queensland to eastern Victoria, scattered over *ca.* eight IBRA7 Regions (Commonwealth of Australia 2012). Found in montane open forests or woodlands often in moist grassy sites (VicFlora 2018). (Figure 17b)

Conservation status: Widespread, common and well represented in conservation reserves.

Flowering period: December to April.

Cytology: No data available.

Note: Bentham (1866) regarded *P. hieracioides* and *Podolepis longipedata* A.Cunn. ex DC. as synonymous, however the two are quite distinct morphologically and tend to occupy different habitats.

Podolepis longipedata A.Cunn. ex DC. *Prodr.* 6: 163 (1838)

Type: **QUEENSLAND.** 'In Novae-Cambriae austr. littoribus arenosis ad sinum Moreton, oct. flor. legit cl. Cunningham....(v. s. comm. á cl. inv.)' (In Queensland Australia by the sandy shore of the Moreton Bay, flowering October, collected by the celebrated Cunningham): Queensland, Moreton Bay, no date, *A. Cunningham s.n.* (lectotype *fide* G.L. Davis (1957), MEL 2280269! (Figure 10), isolectotypes, MEL 2280270!, G-DC 00461472, photo! JSTOR Global Plants, K 000899335, photo! JSTOR Global Plants).

Scaliopsis lucaeana Walp. *Linnaea* 318 (1840). ***Type*: AUSTRALIA**. 'in Novae Hollandia legit Lhotsky': (not located).

Podolepis lucaeana (Walp.) Walp. *Repert. Bot. Syst.*6(2): 235 (1846). Basionym: *Scaliopsis lucaeana* Walp.

Podolepis mitchellii Sond. *Linnaea* 25: 508 (1853). ***Type*: QUEENSLAND**. 'Nov. Holland. subtropica. Sir Th. Mitchell. (Spec. comm. cl. Lindley)': Maranoa Trop. Australia, i.i.1846, *T.L. Mitchell s.n.* (lectotype *fide* G.L. Davis (1957), MEL 222562!).

Podolepis lucaena A.D.Chapm. *Australian Plant Name Index* 2340 (1991) *nom. illeg.* (orth. var. of *Podolepis lucaeana*).

Illustrations: Davis (1957) Figs 17–24; Beadle (1980) Figure B; PlantNET (2018).

Annual *herb* to 60 cm tall. *Stems* 1–several, erect, simple or few-branched, woolly to glabrescent. *Leaves* scabrous to glabrescent, margins entire; basal leaves broad-linear to oblanceolate, 5–20 cm long, 0.5–2.5 cm wide, stem-clasping at base, apex acute, soon withering; cauline leaves alternate, sessile, stem-clasping, decurrent, usually linear to narrow-lanceolate, mostly 3–13 cm long and 3–10 mm wide, decreasing in size up the stem, apex acute to acuminate. *Peduncles* 1–5 cm long. *Inflorescences*1–few per plant. *Capitula* hemispherical, mostly 1.5–2 cm diam., 3–10 arranged in elongated terminal panicles. *Involucral bracts* unequal, triangular, acute, scarious, smooth, glabrous, shiny, reddish-brown with ciliate margins; intermediate bracts 7–9 mm long, with linear glandular claws much longer than the lamina; inner bracts scarious, long-clawed. *Ray florets* yellow, 30–40, female, uniseriate, with a ligule-like limb 15–20 mm long, 2–4-lobed. *Disc florets* yellow, bisexual, numerous. *Cypselas* terete, 1.5–2 mm long, c. 1 mm wide, minutely papillose; pappus bristles 20–30, shortly connate at base, minutely barbellate.

***Selected specimens examined*: SOUTH AUSTRALIA**. Mount Ive Station near Gairdner, 8.iv.1993, *R.J. Bates 32125* (MEL 2373566); Googs Track SW of Tarcoola, 23.x.2004, *M.C. O'Leary 4670* (MEL 2374465). **QUEENSLAND**. Fraser Island. Orchid Beach airstrip, 3.ix.2004, *P.I. Forster 30190* (MEL 2301700); 25 km N of Charleville, 14.ix.1987, *P.S. Short 3054* (MEL 1556550). **NEW SOUTH WALES**. 'Lisgar', about 15 km S of Yetman on Warialda road, 1 km ENE of homestead, 15.x.1992, *C.W.E. Moore 9259* (CANB 433023.1); 10 km from Mungindi towards Moree, 11.ix.1975, *B. Muffet M5/339* (CBG 60357.1).

Distribution and habitat: Widespread and sometimes locally common from south-eastern Queensland to central New South Wales, with isolated occurrences in South Australia near Lake Gairdner and Mount Finke, and scattered across seven IBRA7 Regions (Commonwealth of Australia 2012). Found mostly in mallee scrub on sandy soils (PlantNET 2018). (Figure 17c)

Conservation status: Widespread, common and well represented in conservation reserves.

Flowering period: Mostly October to December but other times in response to rain.

Cytology: Chromosome number determinations of n=10 and 2n=20 have been reported by Turner (1967) as *Podolepis neglecta,* and Watanabe *et al.* (1999).

Notes: See note under *P. hieracioides*. *Podolepis longipedata* var. *robusta* Maiden & Betche is now referred to *Podolepis robusta* (Maiden & Betche) J.H. Willis (see Frood 2015).

Podolepis monticola R.J.F.Hend. *Contr. Queensland Herb.* 2: 1, figs 1–3 (1969)

Figure 11. Isotype of *Podolepis monticola* (MEL 2280271). Reproduced with permission from Royal Botanic Gardens Victoria.

Type: **QUEENSLAND.** Moreton District: Lamington National Park – Araucaria Lookout near "Binna Burra" Lodge, in rock crevices on an exposed south-easterly slope, ii.xi.1965, *R.J.F. Henderson H127* (holotype, BRI 077216!, isotypes, MEL 2280271! (Figure 11), CANB 196785!, AD 97115172!, US 00128309, photo! JSTOR Global Plants, K 000899353, photo! JSTOR Global Plants, TEX 00373736, photo! JSTOR Global Plants).

Illustration: Henderson (1969) Figure 2.

Perennial *herb* to 50 cm tall. *Stems* 1–several, woody, prostrate, simple or few-branched, with an apical rosette of leaves and an erect lanate flowering stem. *Leaves* sparsely tuberculate to lanate above, lanate below, margins entire; basal leaves ovate to obovate, 10–21 cm long, 3.5–6.5 cm wide, gradually narrowed into a winged petiole, stem-clasping at base, apex obtuse, acute or acuminate; cauline leaves alternate, sessile, stem-clasping, decurrent, usually linear to ovate or obovate, mostly 5–18 cm long and 1–5 cm wide, decreasing in size up the stem, apex obtuse to acuminate. *Peduncles* 5–20 cm long, bracteate. *Inflorescences*1–few per plant. *Capitula* hemispherical, mostly 2–2.5 cm diam., 1–10 arranged in elongated terminal panicles. *Involucral bracts* unequal, ovate, acute to obtuse, scarious, smooth, glabrous, shiny, reddish-brown with minutely ciliate margins; intermediate bracts 9–11 mm long, with linear glandular claws about as long as the lamina; inner bracts scarious, claws longer than lamina. *Ray florets* yellow, 25–35, female, uniseriate, with a ligule-like limb 10–15 mm long, deeply 2–4-lobed. *Disc florets* yellow, bisexual, numerous. *Cypselas* terete, 2.5–3.5 mm long, c. 1 mm wide, smooth or minutely papillose; pappus bristles 20–30, shortly connate at base, minutely barbellate.

***Selected specimens examined*: QUEENSLAND**. McPherson Range, Araucaria Lookout, 27.vi.1980, *I.R. Telford 8219* (CBG 8004392.1); Lamington National Park near Araucaria Lookout (c. 10 km from Binna Burra Lodge), 2.x.1996, *K. Watanabe 625* (MEL 2034680). **NEW SOUTH WALES**. Tweed Range, Border Ranges National Park, The Pinnacle, 24.viii.1988, *B. Barnsley 1479* (CBG 8802568.1); McPherson Range, Mt Merino near summit. Lamington N.P., 16.xii.1967, *S.T. Blake 22868* (BRI AQ 0270271).

Distribution and habitat: Known only from near the border between New South Wales and Queensland on the McPherson Range in Lamington National Park and the Border Ranges National Park. IBRA7 Regions: Brigalow Belt South and South Eastern Queensland (Commonwealth of Australia 2012). Found on exposed faces of scarps on the upper slopes of the ranges at altitudes of c. 1100 m, with a vegetation of *Nothofagus* closed forest, but also in drier open *Eucalyptus* forest, exposed to westerly winds. Grows in shallow soil of basalt origin (Henderson 1969). (Figure 17d)

Conservation status: Of limited distribution and regarded as Vulnerable (VU) by criteria of IUCN (2018). All known populations are within national parks.

Flowering period: Mostly October to February.

Cytology: Chromosome number determinations of n=10 and $2n$=20 were reported by Henderson (1969) and Watanabe *et al*. (1999).

Podolepis nutans Steetz, *Pl. Preiss.* 1(3): 464 (1845)

Type: **WESTERN AUSTRALIA.** 'In arenosis terrae inferioris. Herb. Preiss. No. 58' (in poor sandy ground): In Nova Hollandia (Swan River Colonia), 1843, *J.A.L. Preiss 58* (lectotype *fide* G.L. Davis (1957), MEL 2280272 part A! (Figure 12), isolectotypes, MEL 2280272 part B!, MEL 304114!, S S-G-4945, photo! JSTOR Global Plants, LD 1039844, photo! JSTOR Global Plants, G 00301386, photo! JSTOR Global Plants).

Illustrations: Davis (1957) Figs 84–91; Grieve and Blackall (1975) page 792.

Annual *herb* to 25 cm tall. *Stems* 1–many, erect, usually branched, sparsely woolly to glabrescent. *Leaves* sparsely woolly below, more or less glabrous above, margins entire; basal leaves only present on young plants; cauline leaves alternate, sessile, stem-clasping, decurrent, usually lanceolate to broad-linear, 1–6 cm long and 3–8 mm wide, apex acute. *Peduncles* to c. 10 cm long. *Inflorescences* 1–many per plant. *Capitula* campanulate, mostly 1–1.5 cm diam., usually solitary. *Involucral bracts* unequal, transverse-elliptic, reddish-brown, acute to subacute, scarious, not transparent, rigid, smooth, glabrous, shiny; intermediate bracts 4–7 mm long, lamina broader than long, with slender glandular claws about equal in length to lamina; inner bracts scarious, short-clawed. *Ray florets* white, cream or yellow tinged with purple at the apex, 15–25, female, uniseriate, with a ligule-like limb 5–10 mm long, 2–3-lobed. *Disc florets* white, cream or yellow, bisexual, numerous. *Cypselas* terete, 1–1.5 mm long, c. 0.5 mm wide, minutely papillose; pappus bristles 10–15, free, minutely barbellate.

***Selected specimens examined*: WESTERN AUSTRALIA.**

Figure 12. Lectotype and isolectotype of *Podolepis nutans* (MEL 2280272). Reproduced with permission from Royal Botanic Gardens Victoria.

Mundaring Weir, ix.1947, *A.W. Jessep s.n.* (MEL 2166206); Mokine Nature Reserve, 18 km WNW of York, 8.ix.1985, *G.J. Keighery, J.J. Alford 1205* (PERTH 807982); Wooroloo, 1.x.1907, *M. Koch 1747* (MEL 222582); Armadale, 23.ix.1946, *W.H. Nicholls s.n.* (MEL 644148); Swan View (Jane Brook) National Park, 12.ix.1947, *J.H. Willis s.n.* (MEL 2166204).

Distribution and habitat: Endemic to Western Australia where widespread in the South-West Province and scattered over five IBRA7 Regions (Commonwealth of Australia 2012). Found on sandy soils or loams over limestone or laterite (Western Australian Herbarium 1998–) (Figure 17e).

Conservation status: Widespread but uncommon and apparently represented in conservation reserves.

Flowering period: October to December.

Cytology: No data available.

Notes: The herbarium sheet (MEL 2280272) containing the lectotype consists of two main elements and some fragments. The right hand element (A) was designated by G.L. Davis as the lectotype and the left hand element (B) as an isolectotype (termed a lectoparatype by Davis).

An Allan Cunningham collection, allegedly from Shark Bay, is of dubious provenance.

Siemssenia Steetz, *Pl. Preiss.* 1(3): 467 (1845)

Type species: *Siemssenia capillaris* Steetz

Annual *herbs*, glabrous or somewhat arachnose in leaf axils. *Stems* 1–many, erect, wiry, usually much-branched. *Leaves* entire, apex more or less obtuse; basal leaves (when present) petiolate; cauline leaves alternate, sessile, base amplexicaul, stem-clasping. *Peduncles* filiform, naked. *Inflorescences* usually many per plant. *Capitula* campanulate, usually solitary. *Involucral bracts* free, many-seriate, unequal, lamina greenish with scarious margins indented about half way along each side, glabrous or stereome densely glandular. *Florets* white or yellow; ray florets female, uniseriate; disc florets bisexual, numerous, tubular. *Cypselas* ovoid, minutely papillose; pappus bristles few, plumose.

Siemssenia capillaris Steetz, *Pl. Preiss.* 1(3): 467 (1845)

Podolepis capillaris (Steetz) Diels, *Bot. Jahrb. Syst.* 35(2): 621 (1904); *Podolepis siemssenii* F.Muell., *Fragm.* 5(40): 200 (1866) *nom. illeg.* (based on *Siemssenia capillaris* Steetz), *Podolepis siemssenia* F.Muell. in Benth., *Fl. austral.* 3: 607 (1867) *nom. illeg.* (orth. var. of *Podolepis siemssenii*). ***Type:*** **WESTERN AUSTRALIA.** 'In limosis porrectis illustribus sylvae haud procul a praedio rustic cl. J. (?G.) Moore, terrae superioris, d. 10. Sept. 1839. Herb. Preiss. No. 72.' (In extended muddy clear places of woodland not far from the rustic farm of J. Moore, of better soils): Western Australia. Swan River colony, near the property of G. Moore, x.1839, *J.A.L. Preiss 72* (lectotype *fide* G.L. Davis (1957), MEL 2279065 part A! (Figure 13), isolectotypes, MEL 2279065 part B!, MEL 304115!, MEL 1539405!, MEL 696533!, LD 1055044 photo! JSTOR Global Plants).

Illustrations: Davis (1957) Figs 110–117; Grieve and Blackall (1975) page 792; Jessop and Toelken (1986) Figure 710B; Cunningham *et. al* (1992) page 663; Corrick and Fuhrer (1996) Figure 42; Western Australian Herbarium (2018); VicFlora (2018); PlantNET (2018) (all as *Podolepis capillaris*).

Annual *herb* to 45 cm tall. *Stems* 1–many, erect, wiry, usually much-branched, reddish with a grey waxy coating, glabrous except for cobwebbed hairs in leaf axils. *Leaves* glabrous, margins entire; basal leaves oblanceolate to elliptic, 3–4.5 cm long, to c. 10 mm wide, soon withering; cauline leaves alternate, sessile, stem-clasping, usually linear, 0.5–4cm long, 1–2 mm wide, apex obtuse. *Peduncles* mostly 1–4 cm long. *Inflorescences* usually many per plant. *Capitula* campanulate, mostly 3–6 mm diam., wider than long, usually solitary. *Involucral bracts* unequal, ovate, greenish with scarious margins indented about half way along each side, obtuse, entire, glabrous, shiny; intermediate bracts 3.5–5 mm long, claws longer than lamina; inner bracts long-clawed. *Ray florets* white or yellow, 9–12, female, uniseriate, with a ligule-like limb 2–2.5 mm long, often with a purplish line, about as long as involucre. *Disc florets* white or yellow, bisexual, 17–22, corolla asymmetric, split down one side. *Cypselas* ovoid, c. 1 mm long, c. 0.5 mm wide, minutely papillose; pappus bristles 15–18, free, 1–2 mm long, absent from ray cypselas.

Key to species of *Siemssenia*.

1 Involucral bracts completely glabrous; capitula about as long as wide; ray florets 9–12 ..... ***S. capillaris***

1: Involucral bracts with the stereome densely glandular; capitula wider than long; ray florets 5–7 ..... ***S. microcephala***

Figure 13. Lectotype and isolectotype of *Siemssenia capillaris* (MEL 2279065). Reproduced with permission from Royal Botanic Gardens Victoria.

***Selected specimens examined*: WESTERN AUSTRALIA**. Cullimbin Reserve, E of Manmanning, 7.x.1983, *M.G. Corrick 8650* (MEL 105919); c. 16 km from Carnamah, along Eneabba Road, 23.x.1983, *P.S. Short 2191* (MEL 1524743). **NORTHERN TERRITORY**. Simpson Gap National Park, Simpson Gap area, 15 km W of Alice Springs P.O., 6.vi.1974, *A.C. Beauglehole 45029* (MEL 1586180); 7 miles SW of Eridunda, 24.iv.1974, *P.K. Latz 4934* (MEL 526637). **SOUTH AUSTRALIA.** c. 34 km W of Pimba, 28.viii.1989, *P.S. Short 3704* (MEL 695040); Mount Wudinna, 15.x.1995, *K. Watanabe 334* (MEL 2027517). **QUEENSLAND.** Currawinga National Park, 7 km along Lake Numalla Road off Thargomindah Road, 7.iii.1996, *P.I. Forster 18671* (MEL 258339); Between Stokes Range and Coopers Creek, *W.F. Wheeler s.n.* (MEL 696514). **NEW SOUTH WALES.** Balranald district just S of Boree Plains Homestead towards Wampo Station, 12.x.1979, *E.M. Cannng 4716* (MEL 1575118); Southern boundary of Mallee Cliffs National Park, NNE of Euston off the Sturt Highway, 10.x.2000, *R.G. Coveny 18785* (MEL 2067889). **VICTORIA.** c. 5.5 km SW of Cramenton. East-west running track forming the northern boundary of F1 land E of Calder Highway, 24.iv.1985, *D.E. Albrecht 1759* (MEL 690376); At northern end of Lake Albacutya, 50 metres S of Outlet Creek outlet, 7.ix.1978, *T.B. Muir 5922* (MEL 562726).

Distribution and habitat: Occurs in all mainland Australian States as well as the Northern Territory, often in dry inland areas and scattered over *ca.* 33 IBRA7 Regions (Commonwealth of Australia 2012). Found mostly in mallee communities on sandy soils (VicFlora 2018). (Figure 17f)

Conservation status: Widespread, common and well-represented in conservation reserves.

Flowering period: Mostly August to March, but also following rain.

Cytology: Chromosome number determinations of n=3 and $2n$=6 were reported by Turner (1967), Short (1986) and Watanabe et al. (1999) under the name *Podolepis capillaris*.

Notes: The herbarium sheet containing the lectotype (MEL 2279065) consists of two main elements and some fragments. The right hand element (A) was designated by G.L. Davis as the lectotype and the left hand element (B) as an isolectotype (termed a lectoparatype by Davis). The protologue states that the collection locality was near the property of J. Moore, possibly this is a misprint of G. Moore, the name that appears on the lectotype.

Siemssenia microcephala (Benth.) Jeanes, ***comb. nov.***

Basionym*:** *Podolepis microcephala* Benth. *Fl. austral.* 3: 607 (1867). ***Type: **WESTERN AUSTRALIA.** 'Shark's Bay, Milne': Shark Bay, no date, *Milne s.n.* (lectotype here designated, K000899351, photo! JSTOR Global Plants, isolectotype, K000899350 photo! JSTOR Global Plants); Shark Bay [Denham], no date, *W.G. Milne s.n.* (probable isolectotype, PERTH 01182471!).

Illustrations: Davis (1957) Figs 118–125; Grieve and Blackall (1975) page 793. (both as *Podolepis microcephala*).

Annual *herb* to 25 cm tall. *Stems* 1–many, erect, wiry, usually much-branched, reddish-purple with a waxy grey bloom, glabrous except for cobwebbed hairs in leaf axils. *Leaves* glabrous, margins entire, recurved; basal leaves oblanceolate to elliptic, 3–3.5 cm long, to c. 8 mm wide, soon withering; cauline leaves alternate, sessile, stem-clasping, usually linear, 0.5–3.5 cm long, 1–2 mm wide, apex obtuse. *Peduncles* mostly 1–4 cm long. *Inflorescences* usually many per plant. *Capitula* campanulate, mostly 4–8 mm diam., about as wide as long, usually solitary. *Involucral bracts* unequal, ovate, greenish and densely glandular with scarious margins indented about halfway along each side, obtuse, entire, shiny; intermediate bracts 3.5–5 mm long, claws longer than lamina; inner bracts long-clawed. *Ray florets* white (rarely yellow), 5–7, female, uniseriate, with a ligule-like limb 2–2.5 mm long, about as long as involucre. *Disc florets* white (rarely yellow), bisexual, 15–25, corolla asymmetric, split down one side. *Cypselas* ovoid, c. 1 mm long, c. 0.5 mm wide, minutely papillose; pappus bristles 12–16, free, 1–2 mm long, absent from ray cypselas (Figure 14).

***Selected specimens examined*: WESTERN AUSTRALIA**. Mission Road, 35 km WNW of Kojonup, 15.i.1996, *C.M. Lewis 230* (PERTH 4945883); Denham to Hamelin road, c. 21 km SSE of Denham, 15.ix.2012, *A.N. Schmidt-Lebuhn 1447* (MEL 2390796); Hamelin Pool, shell-dunes immediately above stromatolites, 8.x.1993, *P.S. Short 4098* (MEL 2018235); "World Heritage Area" sign along Hamelin Pool to Denham road (41 km E of Overlander), 27.x.1995, *P.S. Short 4499* (MEL 2027964).

Distribution and habitat: Endemic to Western Australia where found mostly in the Eremaean Province

Figure 14. Representative specimen of *Siemssenia microcephala* (MEL 2027967). Reproduced with permission from Royal Botanic Gardens Victoria.

in the vicinity of Shark Bay, but with isolated occurrences in the South-West Province near the Stirling Ranges. IBRA7 Regions: Carnarvon, Jarrah Forest, Mallee and Yalgoo (Commonwealth of Australia 2012). Grows on sandy or clay loams, around salt lakes or samphire flats, sometimes in heathland (Western Australian Herbarium 1998–). (Figure 18a)

Conservation status: Not threatened and well-represented in conservation reserves.

Flowering period: September to November.

Cytology: Chromosome number determinations of *n*=*ca*. 12 were reported by Turner (1967) and *n*=11, 2*n*=22 by Watanabe et al. (1999) under the name *Podolepis microcephala*.

Note: The herbarium sheet containing the type specimens consists of two herbarium numbers (K000899351 and K000899350), five plant specimens and various small labels. The bottom three plant specimens are associated with the herbarium number K000899351 and appear to have been seen by Bentham as suggested by two labels at the bottom of the sheet. These three specimens have been chosen by me as the lectotype. The remaining two specimens mounted at an angle at the top of the sheet are isolectotypes. The PERTH 01182471 specimen is possibly also an isolectotype.

Walshia Jeanes ***gen. nov.***

Type species: W. kendallii (F.Muell.) Jeanes

Annual *herbs* to 35 cm tall. *Stems* 1–many, erect or decumbent, wiry, usually somewhat branched, glabrous except for woolly younger growth. *Leaves* glabrous, margins entire; basal leaves oblanceolate to elliptic, 2–3 cm long, to c. 8 mm wide, soon withering; cauline leaves alternate, sessile, stem-clasping, usually linear, 1–5 cm long, 1–2 mm wide, margins recurved, apex subacute. *Peduncles* mostly 1–4 cm long, leafy. *Inflorescences* usually many per plant. *Capitula* campanulate to hemispherical, mostly 1–2 cm diam., usually solitary. *Involucral bracts* unequal, lanceolate to elliptical, light brown, the scarious lamina rugose, margins fringed with short hairs, apex acuminate; intermediate bracts 5–8 mm long, claws about as long as lamina; inner bracts long-clawed. *Outer florets* yellow, 4–6, female, uniseriate, tubular, with a 3–4-lobed corolla and no pappus. *Disc florets* yellow, bisexual, 10–25, corolla 5-lobed, with a pappus of 7–10 shortly plumose bristles. *Cypselas* conical, curved, c. 2 mm long, c. 1 mm wide, covered with long finger-like papillae (Figure 1).

Note: The various consensus trees derived by Konishi *et al.* (2000) show *Walshia* (as *Podolepis kendallii*) grouping with *Waitzia*. The fruit morphology of *Walshia* however is quite different from that of *Waitzia* in that the latter has obovoid, ellipsoid or terete fruit (conical in *Walshia*), with a long-beaked pappus (beakless in *Walshia*) and the surface is covered with small conical papillae (much larger finger-like papillae in *Walshia*). Analysis of a larger sample of taxa in the *Waitzia* group may clarify the relationships of *Walshia* and other members of the Gnaphalieae.

Etymology: Named in honour of my colleague Neville G. Walsh (1956–) conservation botanist and taxonomist at the National Herbarium of Victoria. Neville is a recognised expert in the Rhamnaceae and Poaceae and has made significant contributions to our understanding of many Australian plant families including Asteraceae through his revision of *Centipeda* and *Eriochlamys* and his work on other genera most notably *Coronidium*, *Craspedia*, *Leucochrysum* and *Olearia*.

Walshia kendallii (F.Muell.) Jeanes, ***comb. nov.***

Basionym: *Helipterum kendallii* F.Muell., *Fragm.* 8(66): 168 (1874); *Podolepis kendallii* (F.Muell.) F.Muell., *S. Sci. Rec.* 3: 68 (1883). ***Type:*** **WESTERN AUSTRALIA.** 'In vicinia sinus Champion's Bay; Guerin.' (near Champion Bay; Guerin): Champions [=Champion] Bay, 1871, *J.Guerin s.n.* (lectotype here designated, MEL 305199! (Figure 15), isolectotype, MEL 305200!).

Podolepis kendallii (F.Muell.) F.Muell. var. *nanus* Ewart, *Proc. Roy. Soc. Victoria* 20(1): 83 (1907) (as *Podolepis kendalli*, orth. var.). *Type*: WESTERN AUSTRALIA. 'Waterloo [=Watheroo], W.A., Max Koch, 1906. Champion Bay, W.A., L. Gould 1890': Watheroo, Western Australia, Rabbits Fence, viii.1906, *Max Koch 1359* (lectotype here designated, MEL 2280266!); Western Australia, Champion Bay, 1890, *L. Gould s.n.* (syntype, MEL 2280267!)

Illustrations: Davis (1957) Figs 134–141; Grieve and Blackall (1975) page 790. (both as *Podolepis kendallii*).

Description: As per genus.

***Selected specimens examined*: WESTERN AUSTRALIA**. 56 km NW of Meekatharra on road to Gascoyne Junction,

Figure 15. Lectotype of *Helipterum kendallii* (MEL 305199) = *Walshia kendallii*. Reproduced with permission from Royal Botanic Gardens Victoria.

25.viii.1996, *J. Barker 64* (MEL 2108486); Beside Northern Highway 63 km N of Paynes Find, 13.ix.1992, *M.G. Corrick 10943* (MEL 2014114); 12 km from Yuin towards Tardie, 13.ix.1986, *P.S. Short 2898* (MEL 1555414); 20.8 km E of Leonora, 19.x.1995, *K. Watanabe 353* (MEL 2027541).

Distribution and habitat: Endemic to Western Australia where found in the Eremaean Province and the South-West Province scattered across seven different IBRA7 Regions (Commonwealth of Australia 2012). Grows in red sand, clay, clay loam, alluvium on floodplains, clay flats and along watercourses (Western Australian Herbarium 1998–). (Figure 18b)

Conservation status: Not threatened and well-represented in conservation reserves.

Flowering period: Mostly August to November.

Cytology: Chromosome number determinations of n=11, $2n$=22 were reported by Turner (1967) and by Watanabe *et al.* (1999) under the name *Podolepis kendallii*.

A new combination with relevance to *Podolepis*

Coronidium gnaphalioides (Domin) Jeanes ***comb. nov.***

Basionym: *Podolepis gnaphalioides* Domin, *Biblioth. Bot.* 22(89): 1230 (1930). ***Type***: **QUEENSLAND**. 'Mt. Remarkable sowie in den Savannenwäldernbei Pentland (DOMIN 111. 1910)': Mt. Remarkable, iii.1910, *K. Domin 9049* (lectotype here designated, PR 531701, photo!); in xerodrymic apud opp Pentland, iii.1910, *K. Domin 9050* (syntype, PR 531702, photo!).

Coronidium lanosum Paul G. Wilson, *Nuytsia* 18: 309 (2008). *Type*: QUEENSLAND. Mt King, *c.* 96 km NNE of Hughenden, 1.iv.1998, *E.J. Thompson, G.P. Turpin & V.J. Neldner HUG692* (holotype, BRI AQ 573739, photo! JSTOR Global Plants)

Helichrysum sp. (Belyando River *V.J. Neldner 3459*). Queensland Herbarium. *Queensland vascular plants* 39 (1994).

A name of uncertain application

Panaetia fulva Lindl., *Edwards's Bot. Reg.* 24: 47 misc. (1838)

Type: **WESTERN AUSTRALIA.** '...annual plant, with the habit of a Gnaphalium, introduced from Swan River by R. Mangles Esq. It flowered in May, 1838...' (not located).

Note: The brief Latin and English descriptions of *Panaetia fulva* in the protologue would suggest that this taxon does not belong to *Panaetia* or *Podolepis*. Unfortunately type specimens have not been located either on JSTOR Global Plants or in the Lindley herbarium at Cambridge University (CAM).

For a detailed discussion see Davis (1957).

Acknowledgements

My thanks go to Neville Walsh (MEL) for several Latin translations and help with the interpretation of a number of ambiguous type specimens. Thanks also to Pina Milne (Collections Manager, MEL) and Angharad Johnson (Digitising Officer, MEL) for the digital images of several herbarium sheets including types. Special thanks go to Sergei Mosyakin (KW), Svitlana Antonenko (KW) and Otakar Šida (PR) for digital images of type specimens, and to Cécile Aupic (P) for searching for specimens in the Paris historical collections on my behalf. Tony Bean (BRI) and Val Stajsic (MEL) kindly collaborated with me to resolve a long-standing taxonomic problem. I am indebted to the directors, collection managers and curatorial staff at AD, BRI, CANB, DNA, MEL, NT and PERTH for access to specimens. Maps were downloaded courtesy of the Australasian Virtual Herbarium (AVH 2018).

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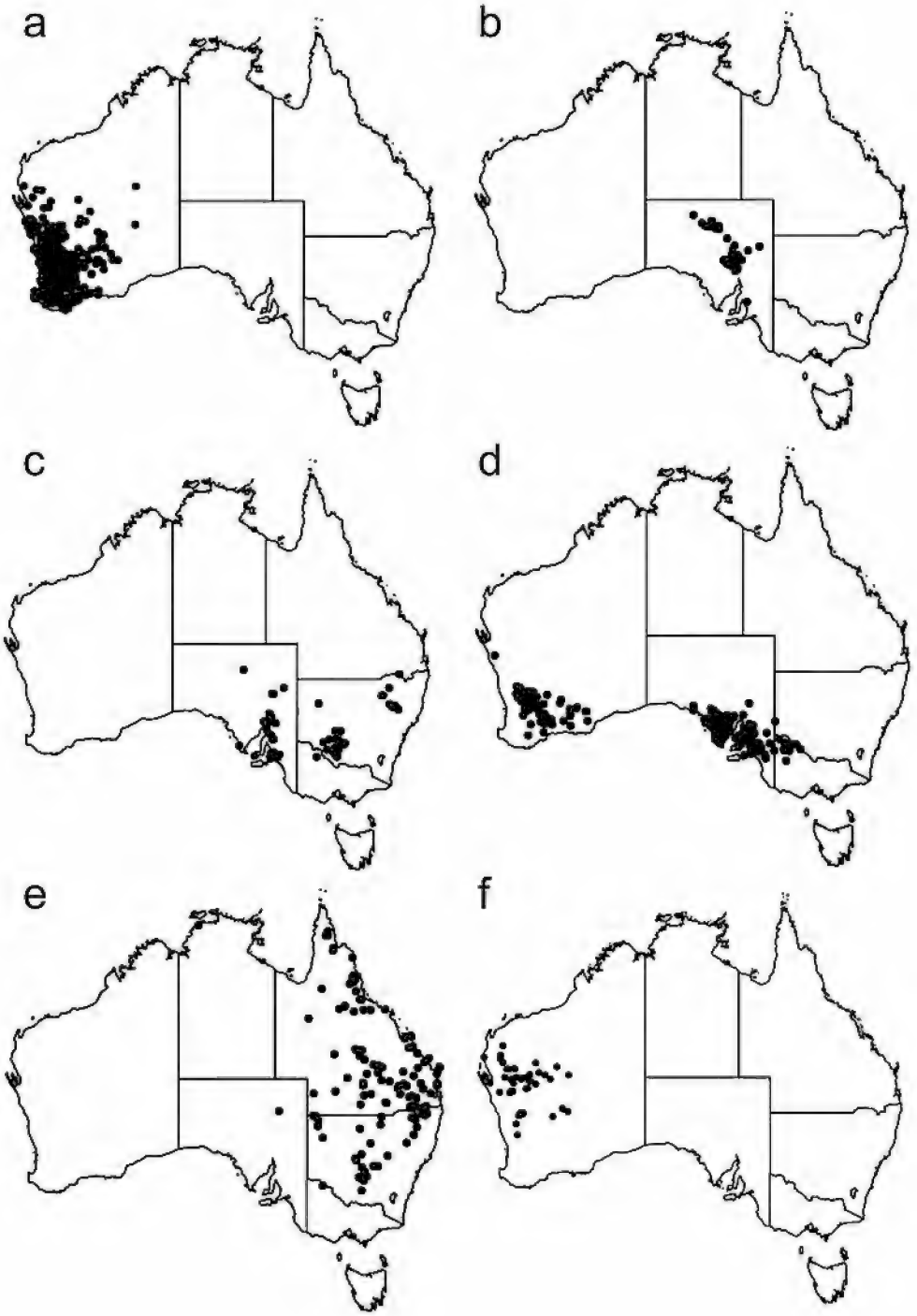

Figure 16. Distribution of **a**. *Panaetia lessonii*; **b**. *Panaetia davisiana*; **c**. *Panaetia muelleri*; **d**. *Panaetia tepperi*; **e**. *Podolepis arachnoidea*; **f**. *Podolepis gardneri*.

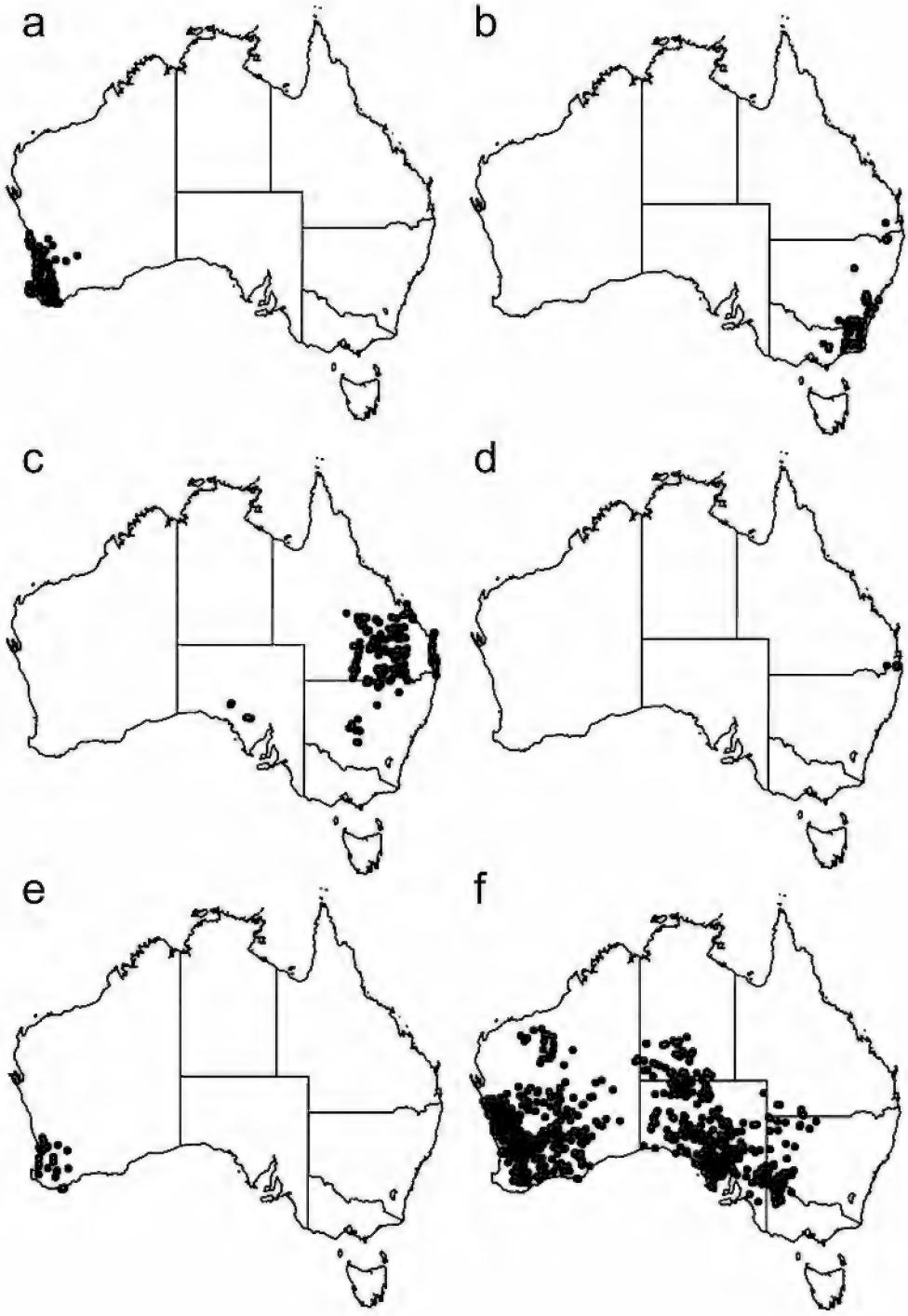

Figure 17. Distribution of **a**. *Podolepis gracilis*; **b**. *Podolepis hieracioides*; **c**. *Podolepis longipedata*; **d**. *Podolepis monticola*; **e**. *Podolepis nutans*; **f**. *Siemssenia capillaris.*

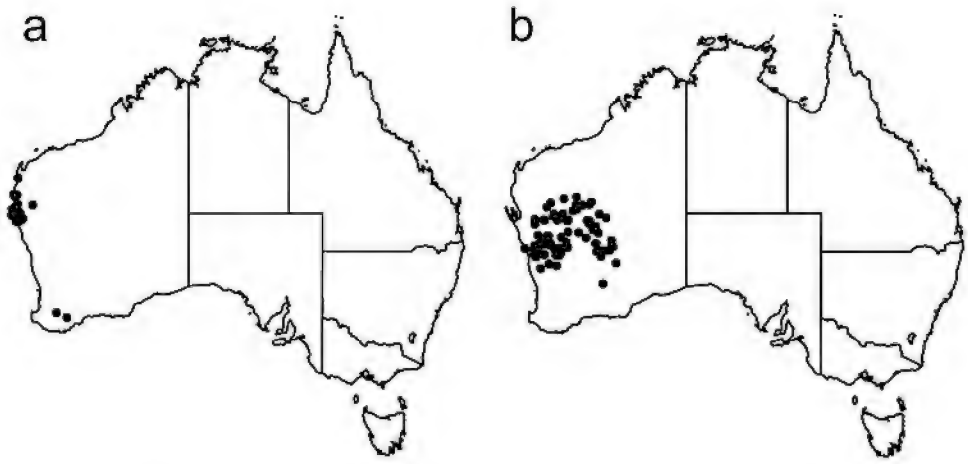

Figure 18. Distribution of **a**. *Siemssenia microcephala*; **b**. *Walshia kendallii*.

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Muelleria

39: 113–126

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ROYAL BOTANIC GARDENS VICTORIA

A phenetic analysis of morphological variation in *Acacia genistifolia* (Fabaceae subf. Mimosoideae), with recognition of three subspecies

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Introduction

Acacia Mill. is Australia's largest plant genus with more than 1,000 species (Maslin 2020). *Acacia* dominates an array of vegetation types and is particularly prominent in the arid zone (Murphy *et al.* 2010). It is unsurprising that research into this genus and the diversity of its members has been extensive, resulting in increasingly refined phylogenies (e.g. Miller *et al.* 2002; Brown *et al.* 2010; Murphy *et al.* 2010). Despite growing confidence in species delimitations across *Acacia*, questions remain about infraspecific variation within species like *Acacia genistifolia* Link. Whilst this species is relatively common throughout its range, two distinct morphotypes have been identified (Court 1972; Maslin 2001a), that have not yet been formally recognised.

Acacia genistifolia commonly forms a straggly, erect to spreading shrub. It has pungent, more-or-less 4-angled phyllodes ranging from virtually flat and oblong to terete and linear. Its flowers form globular, cream to bright yellow heads on relatively long, slender peduncles (Maslin 2001a; VicFlora 2020). Its range includes South Australia, where it is recorded with three collections from one location near Mintaro, north of Adelaide, and an unprocessed fragment from Angaston (M. O'Leary (AD), pers. comm.). No collections have been made in those areas since

Abstract

Acacia genistifolia Link displays morphological variability across its geographic range. To test if this species should be divided into distinguishable taxonomic groups, phenetic analyses of 12 scored characters from 139 specimens were conducted. Three distinct ordination clusters suggested division of the species into three groups. Dendrogram assemblages and geographic distribution patterns supported this distinction. Accounting for overall similarity across the groups, this study resulted in recognition of three discernible entities within *A. genistifolia*, here treated as *A. genistifolia* subsp. *genistifolia*, *A. genistifolia* subsp. *attenuata* A.T.Webb, subsp. nov. and *A. genistifolia* subsp. *platyphylla* A.T.Webb, subsp. nov. A lectotype is selected for *Acacia genistifolia*.

***Keywords*:** wattle, taxonomy, species complex, phenetics

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1990. It is more widespread in New South Wales and the Australian Capital Territory, where it is mostly scattered along the Great Dividing Range, from Dubbo south to Nadgee Nature Reserve. It is also prevalent in Victoria, occurring through the Grampians, central Victoria, Melbourne and near-costal Gippsland. In Tasmania, it occurs primarily in the east, with a few records in the north and northwest of the state, including the Furneaux Group (Figure 3) (Maslin 2001a).

Within its range, *Acacia genistifolia* is perhaps most easily confused with *A. aculeatissima* J.F.Macbr., *A. brownii* (Poir.) Steud., *A. siculiformis* A.Cunn. ex Benth. and *A. ulicifolia* (Salisb.) Court. Each of these species have sharp-tipped phyllodes with four longitudinal nerves and simple, globular inflorescences. *A. genistifolia* can be distinguished from *A. aculeatissima* by its strongly ribbed, glabrous branchlets, from *A. brownii* and *A. ulicifolia* by its longer phyllodes, and from *A. siculiformis* by its longer peduncles and 4-merous flowers (Maslin 2001a).

Acacia genistifolia was first described in 1822. Later that year an additional two names, *A. diffusa* Ker Gawl. and *A. prostrata* Lodd., G.Lodd. & W.Lodd. were erected, both of which are now treated as synonyms of *A. genistifolia* (Court 1972; Maslin 2001a). *Acacia diffusa* was subsequently the most commonly used name for the species (e.g. Rodway 1903; Ewart 1930; Willis 1973) until Court (1972) established that *A. genistifolia* is the correct name for it under its current circumscription (Maslin 2001a). However, multiple forms are encompassed within the current circumscription of *A. genistifolia*, some of which have been previously recognised as separate taxa (*see* Discussion and synonymy of taxa).

Acacia genistifolia has been included in molecular phylogenetic studies focused on reconstructing broad relationships within *Acacia* (Murphy *et al.* 2003; Brown *et al.* 2010; Miller *et al.* 2011). These studies suggest close relationships of *A. genistifolia* with *A. melanoxylon* R.Br. and *A. verticillata* (L'Hér.) Willd., forming a clade sister to the '*Acacia longifolia* group' and its allies. However, this is the first known phenetic study concentrated on this species and involving a sample set covering most of its geographic range and known morphological variation. Through phenetic analysis of variable morphological characters, this study assesses *A. genistifolia* for distinct subgroupings. Taking historical classification and modern observations into account helps to guide hypotheses regarding groups that warrant taxonomic recognition.

Methods

This study utilised 139 herbarium specimens of *Acacia genistifolia*, housed in the National Herbarium of Victoria (MEL), where the authors were based. This allowed relatively even coverage across most of the known distribution of *A. genistifolia*, with 15 specimens from New South Wales and the Australian Capital Territory, 94 from Victoria and 30 from Tasmania (Figure 1). No South Australian material was housed at MEL and so no material from the region could be incorporated into the analyses. This was thought unlikely to alter the outcomes of analyses as South Australian specimens appear similar to the typical *A. genistifolia* from Victoria that were incorporated within the analyses (M. O'Leary, pers. comm.). Initially, it was not certain whether the South Australian occurrence was natural or an introduction, prompting some concerns about including any of that material, however, subsequent information suggests that it is native to South Australia, though now likely extinct or at least functionally extinct in that state as the only well-known specimen, collected from three times, is now dead (M. O'Leary, pers. comm.). The sampling for this study covered previously noted forms from south-east New South Wales and eastern Victoria (long, slender phyllodes) and Tasmania (short, broad phyllodes), and subsequent comparisons with typical plants (Bentham 1853; Maslin 2001a; VicFlora 2020). Each specimen was treated as a separate operational taxonomic unit.

To assess infraspecific variation in *Acacia genistifolia*, 24 morphological characters were scored (Table 1). Character selections were based on characters used to score a related, recently described Victorian *Acacia* species (Orel *et al.* 2020), and which have proven useful in other studies (Conn & Tame 1996; Gardner *et al.* 2005; Ariati *et al.* 2007) and personal observations. Variation within *A. genistifolia* manifests primarily in phyllode morphology. To reflect this variation, seven quantitative and seven multistate characters were initially surveyed. Ultimately, six quantitative phyllode characters (Table 1: 2–7) and an additional two multistate characters addressing phyllode shape (Table 1: 8, 9) were included in analyses. To standardise measurements and eliminate variation associated with plant maturity,

the 7th phyllode on each branchlet was used to score characters except for characters 4 and 6. Character 4 was the longest phyllode and character 6 was the distance between nodes, standardised by measuring between the 7th and 8th nodes and representing mature but non-senescent growth. Phyllode width represents the broadest dimension of phyllodes, which becomes more pronounced in flattened phyllodes displayed by some specimens of *A. genistifolia*. All quantitative measurements were made with five phyllode replicates. Phyllode shapes were defined as: narrow-linear (length >20× width); linear (length 10–20× width); narrow-oblong (length to 10× width); narrow-ovate; sub-falcate (inner margin concave, outer margin convex); subulate (base slightly broader than apex). Phyllode cross-section shapes were defined as: terete (Figure 4, A); subterete (slightly flattened); rhombic (Figure 4, B); flattened (Figure 4, C) (Maslin 2018).

Several inflorescence and fruiting characters were surveyed to support variation present in phyllodes (Table 1). However, insufficient representation in most specimens led to the omission of some of these characters from analyses. This left four inflorescence characters (three quantitative and one binary; Table 1) for inclusion in analyses. For characters 15 and 16, five inflorescence replicates were chosen at random and scored, provided they were at anthesis (anthers exserted) to maintain consistency. Character 17 required that mature buds were counted to provide an accurate estimate of flower number. Flower colour (character 18) was derived from collecting notes only.

Mean values were calculated for all quantitatively scored characters for use in analyses. Classification and ordination analyses were completed using PATN v4 (Belbin 2018). This first generated a matrix of dissimilarity utilising Gower's coefficient (Gower 1971), which allows for equivalent treatment of discrete and continuous measures through range-standardisation of values. Dissimilarity values were subsequently used to generate a dendrogram using agglomerative hierarchical fusion, with the flexible unweighted pair-group method with arithmetic mean (UPGMA) and a beta value of -0.1. A

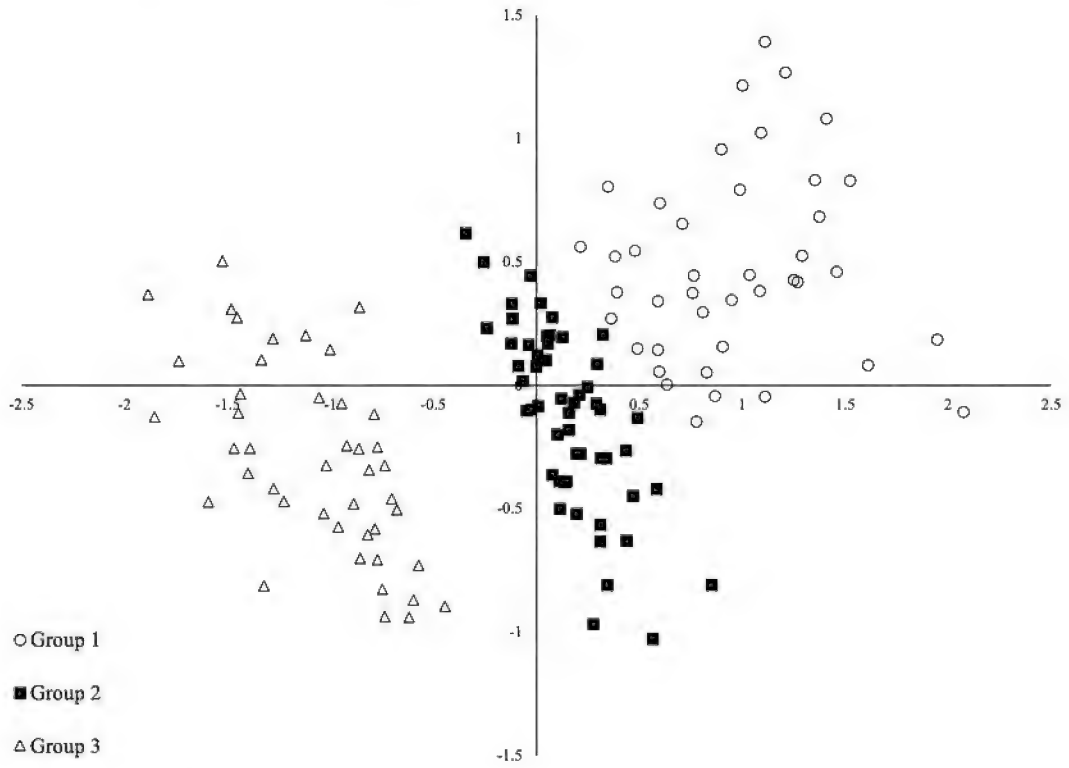

Figure 1. Two-dimensional ordination obtained using SSHMDS (maximum 100 iterations, stress: 0.1502), displaying subgroupings within *Acacia genistifolia*.

two-dimensional ordination was generated with the same matrix, using semi-strong hybrid multidimensional scaling (SSHMDS), based on ten random starts and 100 maximum iterations. How well data points were represented on the plotted ordination was given by a stress value, where lower stress indicated better fit (Kruskal 1964). Kruskal-Wallis (KW) values provided a numerical indication of character significance, where proximity to 100 was most significant (Table 1).

Results

Phenetic analyses resulted in three distinct groups, displayed in Figures 1, 2 and 3. The two-dimensional ordination (max. 100 iterations, stress: 0.1502) resulted in three distinct clusters, here named groups 1, 2 and 3, that did not overlap (Figure 1). The group 3 cluster was clearly separated from a cluster including groups 1 and 2. Groups 1 and 2 were separate except for one specimen in group 2 (MEL672060, north-central Victoria) approaching one from group 1 (MEL673656, NSW, Nadgee) (Figure 1).

The dendrogram distinguishes between group 3 and groups 1 and 2 (Figure 2), displayed at the first branching point. Within the core branch encompassing groups 1 and 2 was a divergence of ten group 1 specimens, which originated from across Gippsland. The remaining samples in both groups placed together in a large cluster, split into two fundamental branches which contained either the majority of remaining group 1 or group 2 specimens. Some overlap then existed within each of these branches, with MEL595015 (Victoria,

Table 1. Characters scored for phenetic analyses, with Kruskal-Wallis values presented as an indication of significance of characters included in analyses.

	Scored characters	KW Values
	Branchlet characters	
1.	Indumentum: glabrous (0) present (1)	.....
	Phyllode characters	
2.	*Width of phyllode (mm)	89.402
3.	*Length of phyllode including mucro (mm)	79.202
4.	*Length of longest phyllode (mm)	79.704
5.	*Distance from pulvinus to the gland (mm)	43.574
6.	*Distance between nodes 7 and 8 (mm)	22.255
7.	*Angle of phyllode from stem at 3 mm from node (degrees)	44.804
8.	*Shape of phyllode: narrow-linear (0) linear to sub-falcate (1) subulate (2) narrow-ovate to narrow-oblong (3)	81.185
9.	*Shape of phyllode in cross-section: flattened (0) rhombic to terete (1)	89.571
10.	Ratio of phyllode length to thickness	.....
11.	Internerve indumentum: glabrous (0) present (1)	.....
12.	Primary nerve indumentum: glabrous (0) present (1)	.....
13.	Curvature of phyllode: straight (0) slight to moderate (1) moderate to strong (3)	.....
14.	Hairs (appressed) on phyllode margins: glabrous (0) present (1)	.....
	Inflorescence characters	
15.	*Peduncle length at anthesis (mm)	5.8287
16.	*Capitulum diameter at anthesis (mm)	6.7699
17.	*Maximum number of flowers per capitulum (no. mature buds)	2.5133
18.	*Flower colour: yellow (0) cream to white (1)	0.2527
	Pod characters	
19.	Length (mm)	.....
20.	Width at narrowest point (mm)	.....
21.	Width at widest point (mm)	.....
22.	Distance between seeds (mm)	.....
23.	Curvature: straight (0) curved (1) coiled (2)	.....
24.	Hair density: glabrous (0) sparse (1) moderate (2)	.....

* Denotes character included in analyses.

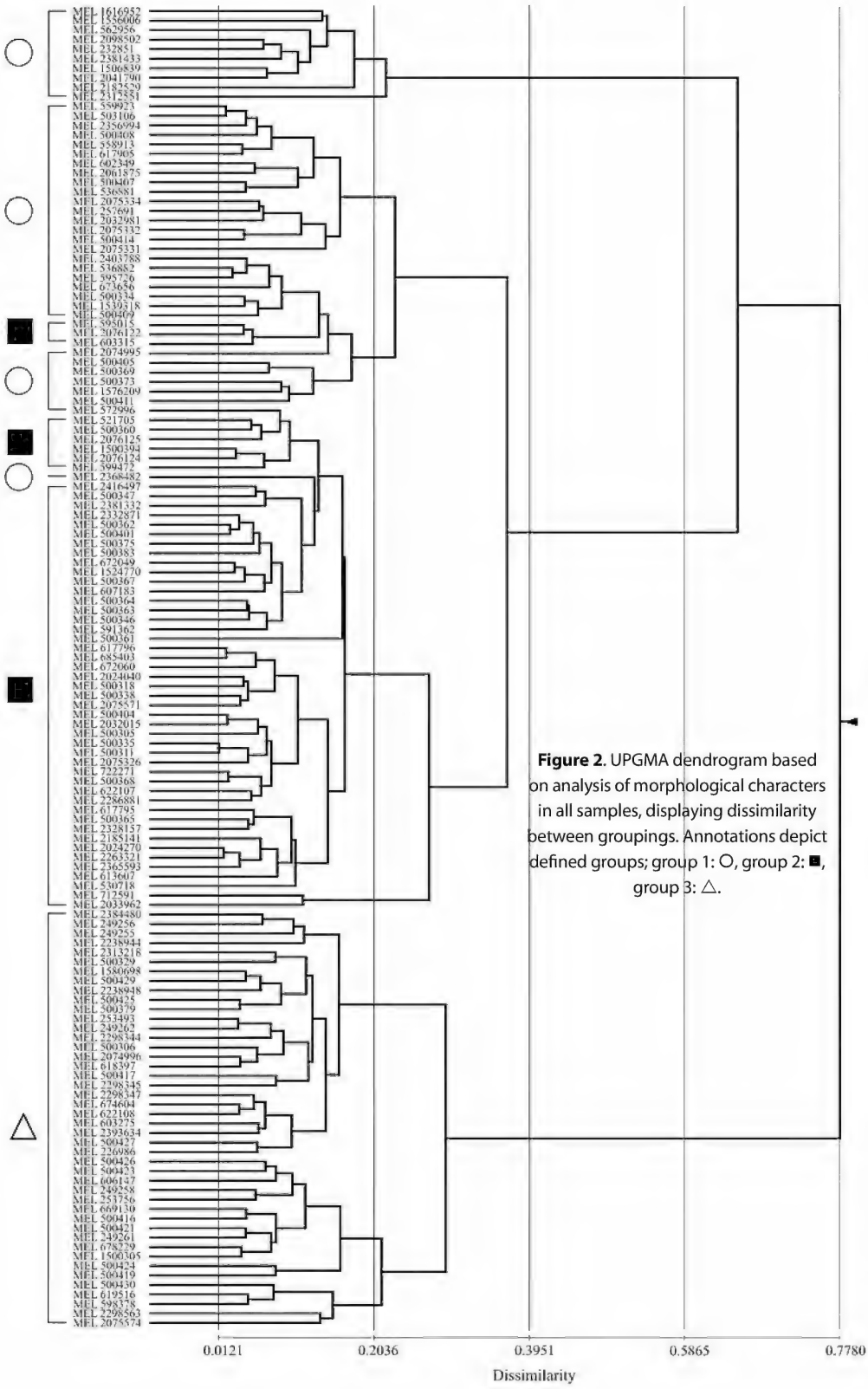

Figure 2. UPGMA dendrogram based on analysis of morphological characters in all samples, displaying dissimilarity between groupings. Annotations depict defined groups; group 1: ○, group 2: ■, group 3: △.

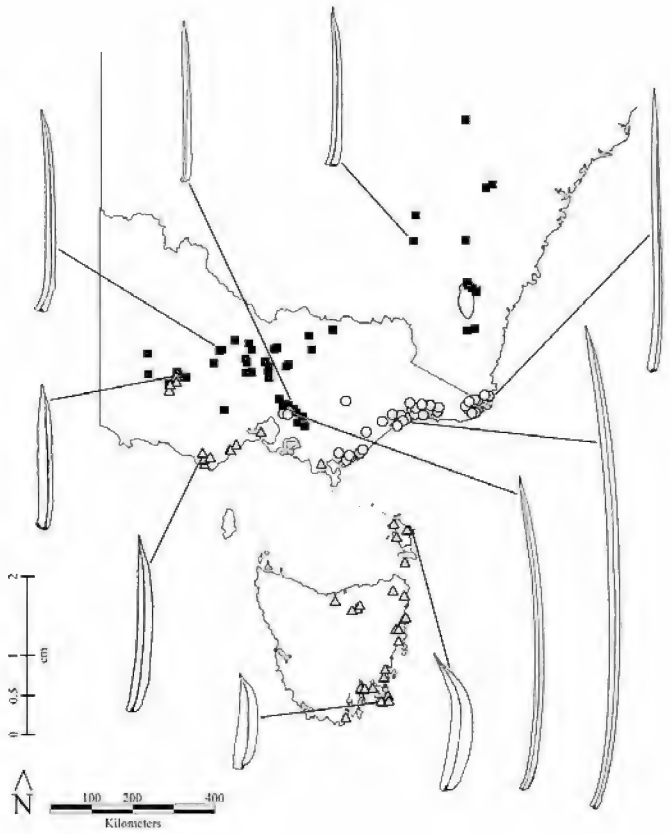

Figure 3. Distribution map displaying specimens included in analyses, symbols depict defined groups; group 1: ○, group 2: ■, group 3: △, scale horizontal. Accompanied by representative phyllode diagrams typical of each group, displaying outlines and primary nerves, scale vertical.

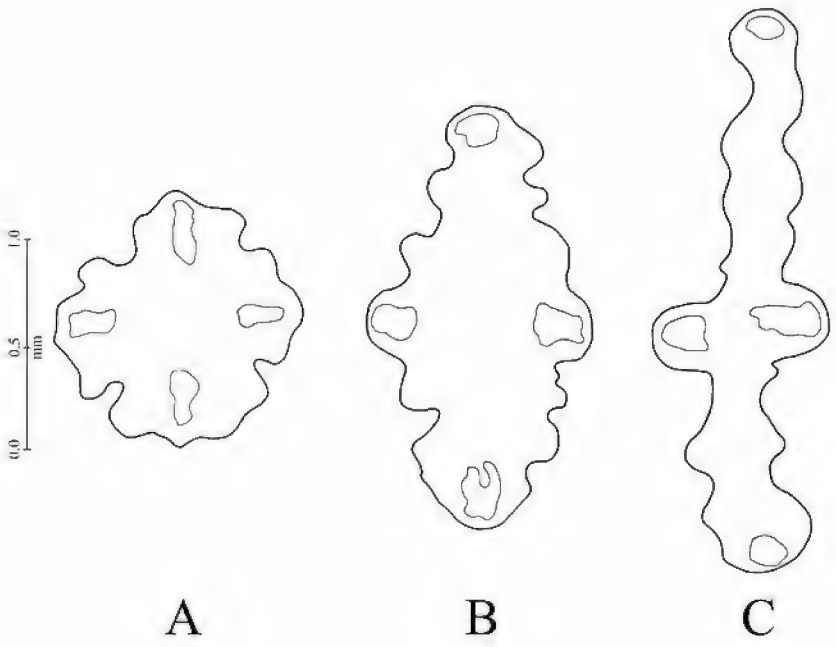

Figure 4. Phyllode cross-sections depicting differences observed in character 9. Primary nervature is indicated within phyllode outlines.

A (MEL712591) typifies subterete to terete shape present in group 1 (○) and group 2 (■).

B (MEL249258) is representative of intermediate, rhombic cross-sections present in group 2 and group 3 (△).

C (MEL606147) typifies flattened cross-sections of group 3.

Nillumbik Shire), MEL2076122 (NSW, Bathurst) and MEL603315 (central Victoria) (group 2) placing amongst the branch containing mostly group 1 samples, and MEL572996 (Victoria, Gippsland) and MEL2368482 (Victoria, Gippsland) (group 1) placing in the group 2 branch.

Distributions of specimens included in this study are presented in Figure 3 according to defined groups. Group 1 specimens were distributed in near-coastal areas from Nadgee Nature Reserve in New South Wales through Gippsland lowlands to east of Wilsons Promontory, with outlying specimens from the Macalister River north of Traralgon, and the Nillumbik Shire (about 40 km north-east of Melbourne). Group 2 specimens were widely distributed through New South Wales and the Australian Capital Territory (other than the south-east coastal area), central and north-eastern Victoria, Melbourne and the Grampians in the west where they overlapped with group 3. All Tasmanian specimens belonged to group 3, which also included specimens from the Grampians, Otways and immediately north-west of Wilsons Promontory in Victoria.

Kruskal-Wallis values (Table 1; Figure 5) indicated that phyllode cross-sectional shape (KW: 89.571) and phyllode width (KW: 89.402) were most significant in distinguishing between groups. Additionally, phyllode shape (KW: 81.185), length of longest phyllode (KW: 79.704) and (mean) phyllode length (KW: 79.202) were significant measures. Group 1 and 2 specimens tended to possess phyllodes that were subterete to terete in cross-section and linear, with those of group 1 narrow-linear. Group 3 included specimens with flattened phyllodes, ranging from linear to narrow-ovate or narrow-oblong. Phyllode width values were lower in groups 1 (0.75–1.5 mm) and 2 (1–1.5(–1.75) mm), compared with those of group 3 ((1.25–)1.5–3 (–4.5) mm). Mean and maximum phyllode lengths were highest in group 1 (mean range: 25–70 mm, max range: 34–95 mm), overlapping slightly with the maximum ranges of the mean in group 2 (mean range: 10–26 mm, max range: 19–42 mm) and group 3 (mean range: 12–27 mm, max range: (14–)19–50 mm). Less significant distinguishing characters included phyllode angle from the stem (KW: 44.804), which was more acute in group 1 (mean: 48.9°) than groups 2 (mean: 67.2°) and 3 (mean: 60.3°), and distance from the pulvinus to the gland on the phyllode (KW: 43.574), which was greatest in group 1 (mean: 4.41 mm) when compared to group 2 (mean: 2.89 mm) and group 3 (mean: 2.37 mm). Characteristics of the inflorescence: peduncle length, capitulum diameter, number of flowers per capitulum and colour, and the distance between nodes, were variable without providing significant support for groupings. Box-and-whisker plots are included (Figure 5) for those characters useful in differentiating between groups.

Discussion

Phenetic analyses indicated three groups within *Acacia genistifolia* worthy of taxonomic recognition. These groups followed trends observed in historical nomenclature, beginning with the description of the Tasmanian *A. prostrata*, which noted distinctly flattened phyllodes resembling specimens recognised here as comprising group 3 (Loddiges *et al.* 1822). This form differed from the typical form of the species that was designated as *A. genistifolia* by Link (Court 1972), and which corresponds to our group 2. This distinction was noted by Bentham (1842), who referred to specimens corresponding to our group 3 form as *A. diffusa*, and our group 2 form as *A. cuspidata* A.Cunn. ex Benth. Bentham (1853) later recognised a form with long, slender phyllodes, '2–2 ½ inches [5–6.3 cm] in length', corresponding to our group 1, as *A. cuspidata* var. *longifolia* Benth., whilst Maslin (2001a) also noted this form, observing phyllodes up to 8 cm long. Similarly, Maslin (2001a) mentioned a Tasmanian form with broad phyllodes, which are included within our group 3. Hence, the distinctions made in this study were not novel, but the study has provided clarity regarding the characteristics that may be used to distinguish them.

Ordination results (Figure 1) depicted groups 1, 2 and 3 as distinct and showed no overlap. The dendrogram (Figure 2) supported separation of group 3 from groups 1 and 2 but showed overlaps between groups 1 and 2 that were not observed in the ordination. However, these results still suggested trends consistent with the ordination in distinguishing between the two groups. These groupings were based primarily on phyllode features. Phyllode shape was useful in distinguishing between groups, with those in group 1 typically linear or narrow-linear, group 2 linear, and group 3 ranging from linear to narrow-ovate or narrow-oblong. Phyllode

cross-section shape and width were the most significant features that differentiated group 3 (flattened; 1.5–3 mm wide) from groups 1 and 2 (rhombic in cross-section to terete; 0.75–1.5 mm wide) (Figure 4). Mean and maximum phyllode lengths were the most useful characters for discriminating between groups 1 and 2, with those of group 1 specimens typically longer. Phyllode lengths only overlapped in the minimum range of the mean of group 1. Phyllode angle from the stem provided some value in separating groups 1 and 2; more acute in group 1 than group 2. However, this character (KW: 44:804) is less reliable than mean (KW: 79.202) and maximum (KW: 79.704) phyllode lengths. Inflorescence characters, though variable, provided little support for these groupings (Table 1).

Geographic distributions patterns of *Acacia genistifolia*

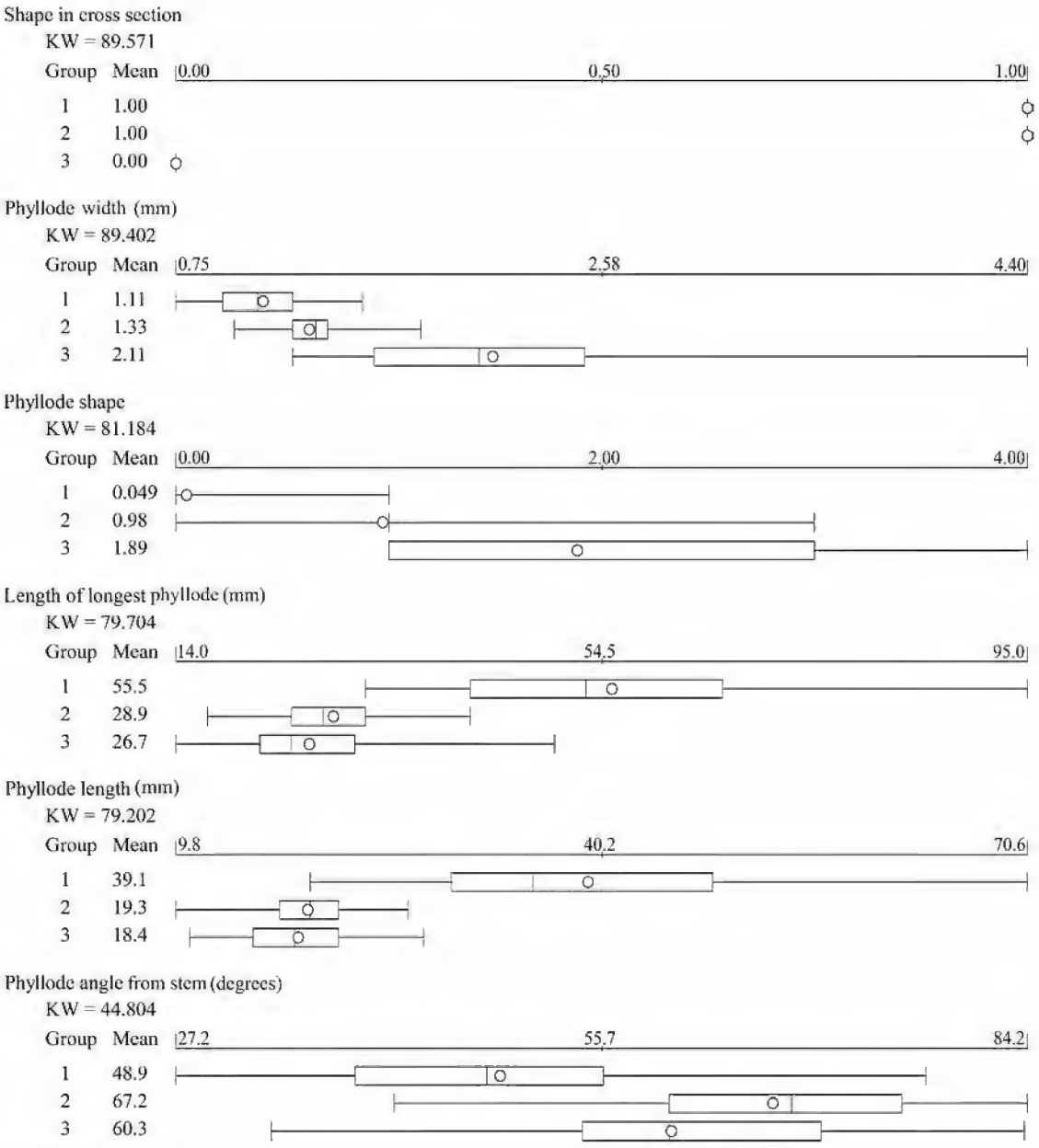

Figure 5. Box-and-whisker plots for characters used in differentiating groups, displaying: 25th–75th percentiles, minimum, maximum and mean values. Kruskal-Wallis (KW) values provide an indication of significance.

groups defined in this study generally aligned with the trends presented in the ordination (Figure 1) and dendrogram (Figure 2). Group 1 is predominantly distributed in near-coastal regions in southeastern New South Wales and eastern Victoria. However, three specimens in this group originated from the Nillumbik Shire and another was labelled 'Macalister' and presumed to be a natural occurrence in the upper rather than lower catchment of the Macalister River. Despite its location further inland and likely at higher elevation than other records, the Macalister River specimen is congruent with other group 1 specimens. The records of group 1 specimens in the Nillumbik Shire are discussed in more detail below. Group 2 exhibited a more dry-adapted, inland distribution that included South Australia and extended from central New South Wales through the Australian Capital Territory and central Victoria to the Grampians, where it overlaps with group 3. Specimens of groups 1 and 2 were allopatric except in the Nillumbik Shire. Group 3 was the only form present in Tasmania, with disjunct mainland Australian populations in the Wilsons Promontory region, Otways and Grampians. This group did not occur in areas occupied by group 1.

It might be expected that the specimens from group 1 and 2 which overlapped in geographic distributions (Figure 3) would be those which overlapped in the dendrogram. This was the case for only one of the group 2 samples placed amongst group 1, with the others being from Bathurst and central Victoria. The same was noted for the group 1 samples placed with group 2 in the dendrogram, both from Gippsland. Hence, geographic range overlap in this region was not correlated with overlap in the dendrogram. Additionally, the separation of a branch including ten group 1 specimens presented a partition within that group (Figure 2), although, this outcome was centred on phyllode length, with all specimens distributed in Gippsland. Ultimately, the recurrence of similar patterns in ordination and dendrogram results, coupled with their distributions, supported division of the *Acacia genistifolia* complex.

Whilst the data presented in the ordination (Figure 2) and dendrogram (Figure 3) support recognition of three taxa corresponding to groups 1, 2 and 3, the appropriate rank for their recognition is debatable. A combination of phyllode morphological differences and generally strong geographic and ecological separation of the groups, with a lack of discriminating reproductive characters, supports their recognition as subspecies within *A. genistifolia* (e.g. Stuessy *et al.* 2014). In some instances, the groups become more morphologically similar to each other when in closer proximity, possibly owing to increased gene flow or because environmental conditions are more similar and have a large influence on their morphology. This is particularly noticeable with the higher similarity in phyllode morphology in group 3 plants relative to group 2 plants in Victoria. Comparatively, the similarity of phyllodes in Tasmanian group 3 plants relative to typical group 2 plants is noticeably less (Figure 3). Occasional weakening in morphological distinction due to environmental conditions or genetic continuity also urges in favour of group recognition as subspecies. Hence, the overarching similarity between the groups is reflected by classifying observed variation at subspecies rank, yet allows for their individual recognition. Recognition of subspecies based primarily on phyllode morphology is also given precedent within other *Acacia* species such as *A. boormanii* (Tucker *et al.* 2018), *A. longifolia* (Maslin 2001b) and *A. victoriae* (Ariati *et al.* 2007). Consequently, the following classification is proposed; group 1 = *A. genistifolia* subsp. *attenuata* A.T.Webb, group 2 = *A. genistifolia* subsp. *genistifolia*, group 3 = *A. genistifolia* subsp. *platyphylla* A.T.Webb. This is the first time designations have been applied at subspecies rank in this group. To avoid nomenclatural confusion and association on the basis of type illustrations (e.g. *A. diffusa*, *A. longifolia*, *A. prostrata*), new names have been applied to group 1 (subsp. *attenuata*) and group 3 (subsp. *platyphylla*). Group 2 includes specimens resembling the type of the species and is recognised as subsp. *genistifolia*.

Phyllodes typically longer than those expected for subsp. *genistifolia* were noted from a few specimens included in this study originating from near Panton Hill, Nillumbik Shire, about 40 km north-east of Melbourne. These plants displayed intermediate morphologies between subsp. *attenuata* and subsp. *genistifolia*. Whilst most specimens from this location placed within group 2 (i.e. subsp. *genistifolia*) some placed within group 1 (i.e. subsp. *attenuata*) in Figure 2, leading to some confusion regarding the identification of specimens

there. Targeted field observations could not confirm the presence of 'typical' subsp. *attenuata* in the area. However, environmental plasticity was observed amongst specimens belonging to subsp. *genistifolia*, with longer, thinner phyllodes present in shaded areas on lower slopes of ranges, or on etiolated new growth. This could explain why collections from this area displayed phyllodes longer than expected. In addition, plants here may be influenced by relatively nearby populations of subsp. *attenuata* or by historic continuity with that subspecies but are now long separated from it. Ultimately, the distributions of subspecies presented in this study support subsp. *attenuata* and subsp. *genistifolia* as allopatric. For these reasons, it is believed that intermediate specimens from this region are best regarded as subsp. *genistifolia*.

Future studies could utilise molecular data to confirm phenotypic patterns presented in this study. A previous study by Brown *et al.* (2010) included two samples of *Acacia genistifolia*; one from group 2 and one from group 3. Their phylogeny derived from ITS and ETS data showed *A. genistifolia* to be polyphyletic. However, in that study much of the sequence data used to generate the phylogeny was missing for *A. genistifolia* samples. Accordingly, the Brown *et al.* (2010) result should be verified with further study.

The following descriptions outline the reinterpretation of *Acacia genistifolia* based on results of phenetic analyses in this study. Scored characters outside of those analysed are included, particularly phyllode length-to-width ratios and pod characters. Outlying measurements are bracketed.

Taxonomy

Acacia genistifolia* Link, *Enum. Hort. Berol. Alt. 2: 442 (1822)

Phyllodoce genistifolia (Link) Link, *Handbuch* 2: 133 (1831), as *genistaefolia*.

Acacia diffusa Ker Gawl. *Bot. Reg.* 8: 634 (1822). Type: plate in *Bot. Reg.* 'Said to be a native of the newly discovered territory on the inland side of the Blue Mountains in New South Wales'.

Acacia cuspidata A.Cunn. ex Benth., *London J. Bot.* 1: 337 (1842); *Acacia diffusa* var. *cuspidata* (A.Cunn. ex Benth.)

Benth., *Fl. Austral.* 2: 333 (1864). Type: New South Wales. Marleys Plains, April 1824, *A.Cunningham 46* (syn: K791425, K791427 photos seen); Vineyard, *Hügel* (1837) (syn: K791431 photo seen); Argyle County, *Fraser* (syn: K791429 photo seen).

***Type*: GERMANY.** Berlin, cultivated in botanic gardens, *Schumann s.n.* (lecto, here designated: MEL39790!).

Open *shrub* to 3 m. *Branchlets* strongly ribbed, stipules inconspicuous, caducous. *Phyllodes* sessile, pungent and rigid, terete to flattened, straight to slightly recurved, 4-veined with a single vein per angle, 0.75–4.5 mm in diameter, (10–)15–70(–95) mm long, diverging from the stem at (33–)40–80(–84)°, gland single, 1–5(–11) mm from pulvinus. *Inflorescences* simple, 2–4 per axil, peduncles slender, 5–19(–24) mm long, basal bract caducous. Heads globular, 10–18-flowered, white to bright yellow. *Flowers* 4-merous. *Pods* submoniliform, linear, sometimes curved (rarely beginning to coil), glabrous or sparsely to moderately covered by short appressed hairs, (34–)40–80(–100) mm long, 2–7 (–8) mm wide. *Seeds* 3.5–5 mm long × 2.5–3.5 mm wide, funicle white to cream, enlarged into an aril at seed base, doubling back and tapering to point of attachment.

***Habitat and Distribution*:** A few records exist in South Australia, from north of Adelaide near Mintaro and Angaston. A single individual was known for many years but has now apparently died (M. O'Leary, pers. comm.), suggesting that this species may now be extinct in the state. Scattered through New South Wales and the Australian Capital Territory, from Dubbo south to Nadgee Nature Reserve, mostly inland of the Great Dividing Range and extending west to Griffith. Widespread in Victoria, excluding the highlands, north-west and south-west of the state. Prevalent in Tasmania, particularly the east and including the islands of the Furneaux Group. Typically grows in dry sclerophyll forests and heathland, below 1000 m.

***Typification*:** The type specimen (MEL39790) is here designated as a lectotype, due to the lack of a cited holotype in the protologue and the apparent lack of a specimen at the Botanic Museum Berlin-Dahlem (B), likely resulting from the massive loss of types at B as a consequence of bombing in the Second World War (e.g. Hiepko 1987). No specimens at other herbaria where Link typically lodged his specimens (e.g. BR, C, FI, H, LIV, P, PH, W; Stafleu & Cowan 1981) were found on the Global Plants website (https://plants.jstor.org/). The label on MEL39790 identifies it as part of the type that

was at B, thus, its designation originally as an isotype by Court (1972).

Acacia genistifolia Link subsp. *genistifolia*

Phyllodes rhombic in transverse section or terete, linear, 1–1.5 mm in diameter, 14–26(–40) mm long, <20 times longer than wide, diverging from the stem at 42–80 (–84)°. *Pods* with sparse covering of short appressed hairs, 50–80(–100) mm long, 2–7 mm wide.

Selected specimens examined (20): **SOUTH AUSTRALIA.** Goyder: side track [0.6 km] of the Gap Road off the Mintaro – Hilltown road, c. 10.5 km from Mintaro, 30.xii.1990, *D.E. Symon 15038* (AD99104585 *n.v.*). Clare and Gilbert Valleys: 6 km due N of Mintaro, Black Hill Native Flora Park, 22.xi.1990, *M. Jusaitis and K. Holliday 14* (AD99049202 *n.v.*). **NEW SOUTH WALES.** Central Tablelands: 8.3 miles east of Bathurst, 14.iv.1972, *R. Coveny 4148* (MEL, NSW). Riverina: 45.4 km from turnoff to Griffith nearest Rankins Springs in Temora, towards Harden, 8.xi.1979, *N. Hall H79/88* (MEL). Southeast: 18km east-northeast of Boorowa, 12.vi.2004, *A.J. Leishman 117* (BRI, CANB, MEL, NSW); c. 1 km from Numeralla towards Cooma, 10.viii.1997, *A.M. Lyne 2377* (CANB, MEL, NSW). **AUSTRALIAN CAPTIAL TERRITORY.** Canberra: Fairbairn Avenue, opposite the stockyard, viii.1963, *Walker ANU1060* (MEL); lower slopes of Black Mountain, 3.ix.1952, *R. Melville 827* (K, MEL). **VICTORIA.** Central West: Wannon, Youngs State Forest, 10.ix.2004, *D. Osler 37* (MEL). Goulburn Valley: Dookie Agricultural College, 4 km south of Mt Major, 26.viii.1992, *I. Crawford 1815 & J. Strudwick* (CANB, MEL); 20 km west-northwest of Seymour, 8.viii.1975, *A.C. Beauglehole 50112* (MEL). Grampians: Roses Gap, 12.viii.1957, *A.J. Hicks s.n.* (MEL500311); Wallaby Rocks, 25.iv.1981, *H.S. Meyer 63* (MEL). Nillumbik Shire: Greensborough, 13.ix.1969, *H. Veitch s.n.* (MEL500405); Hurstbridge, corner of Haleys Gully & Broad Gully Roads, 11.x.1981, *R.A. Kilgour 105* (MEL); Panton Hills, 14.ix.1952, *D. Morton s.n.* (MEL500334). North Central: Inglewood Flora Reserve, 2.0 km northwest of Inglewood, 14.viii.1996, *J.W. Grimes 3442* (MEL, NY); Heathcote-Graytown National Park, 20.viii.2017, *N.G. Karunajeewa 1567* (AK, CHR, DAO, MEL); Dalyenong State Forest, 9 km west-northwest of Archdale, 8.ix.1979, *A.C. Beauglehole 64708* (MEL). Wimmera: 4.xii.1891, *F.M. Reader s.n.* (MEL500383).

***Distribution*:** In South Australia, previously known only from near Mintaro and Angaston and now possibly extinct there. In New South Wales, from Dubbo south to Cooma, including the Australian Capital Territory, extending westward to Griffith. In Victoria, in a more-or-less continuous band between near Rutherglen and the Grampians, and immediately north-east of Melbourne.

***Notes*:** Distinguished from subsp. *attenuata* which has phyllodes that are generally longer (25–70(–90) mm), >20 times longer than wide, and less spreading; intermediates resembling subsp. *attenuata* exist in the Nillumbik Shire north-east of Melbourne. Distinguished from subsp. *platyphylla* which has typically broader phyllodes (>1.5 mm wide) that are flattened in cross-section. Distribution overlaps with subsp. *platyphylla* in the Grampians, where plants in subsp. *genistifolia* and subsp. *platyphylla* have not yet been collected from the same site, despite their close proximity to each other. Further surveying is required to confirm whether the two subspecies are always parapatric, or whether they do coexist in sympatry in some parts of the Grampians. This subspecies is not considered rare or threatened in New South Wales, the Australian Capital Territory or Victoria. However, in South Australia widespread land clearing appears to have resulted in its functional extinction in that state.

Acacia genistifolia Link subsp. *attenuata* A.T.Webb, subsp. nov.

Acacia cuspidata var. *longifolia* Benth., *Linnaea* 26(5): 609 (1855). Type: Victoria, Merrimans Ck, *F. Mueller s.n.* (holo: K 791432 photo seen; iso: MEL500413!, 500414!)

***Type*:** **AUSTRALIA.** Victoria. Gippsland, Raymond Island, 14 km south-east of Bairnsdale, 37° 55′ S, 147° 45′

Key to *Acacia genistifolia* subspecies

1. Phyllodes ≤1.5 mm in diameter, rhombic in cross-section to terete and more-or-less isodiametric, mature pods glabrous or sparsely covered with short appressed hairs. Mainland Australia 2
1: Phyllodes >1.5 mm in diameter, more-or-less flattened in cross-section, mature pods with sparse to moderate covering of appressed hairs. Victoria in the Grampians, Otways and Wilsons Promontory region, Tasmania ..... subsp. *platyphylla*
2: Phyllodes mostly 25–70(–90) mm long, >20 times longer than wide. Southeastern New South Wales, Gippsland ..... subsp. *attenuata*
2: Phyllodes 14–26 mm (rarely to 40 mm) long, <20 times longer than wide. Widespread; South Australia, New South Wales and the Australian Capital Territory, central Victoria including the Grampians and immediately north-east of Melbourne ..... subsp. *genistifolia*

E, 27.ix.1992, *I. Crawford 1890* (holo: MEL1616952, iso: CANB, PERTH)

Phyllodes subterete to terete, sometimes rhombic in transverse section, linear or narrow-linear, (0.75–) 1–1.5 mm in diameter, 25–70(–95) mm long, >20 times longer than wide, diverging from the stem at 38–65 (–77)°. *Pods* mostly glabrous, (35–)40–80(–99) mm long, 2–5(–8) mm wide.

***Selected specimens examined (20)*: NEW SOUTH WALES.** Southeast: Nadgee State Forest, intersection of Range Road and Ireland Timms Road, 27.ix.1984, *D.E. Albrecht 1004* (BRI, MEL); Murrica [Merrica] River, Nadgee Faunal Reserve c. south of Eden, 15.viii.1963, *E.F. Constable 4350* (BRI, CANB, MEL, PERTH). **VICTORIA.** Gippsland: Port Albert, *F.Muell s.n.* (MEL500407); Port Albert 100 m west of main pier, 2.ix.1995, *A. Paget 1325* (MEL); Bruthen Creek, 1892, *W.H.Lucas s.n.* (MEL2075331); heath near Wonboyn and Genoa Rivers, ix.1860, *F. Mueller s.n.* (MEL500411), Sale, lower Thompson River, viii.1893, *A. Purdie s.n.* (MEL2075332); Rotamah Island, 25.viii.1986, *I. Crawford 457* (BRI, MEL, PERTH); Colquhoun State Forest north of Nowa Nowa, 6.iv.1996, *J.W. Grimes 3449* (MEL, NY); Holey Plains State Park, 9.x.2014, *N.G. Karunajeewa, 1031* (DAO, MEL); Croajingalong National Park, 600m from the intersection of New Binns Road on the west side of Duncans Road, 5.xii.2016, *D.J. Ohlsen 653* (MEL); 10 km northwest of Nowa Nowa, 22.viii.1978, *P.K. Gullan 372 & N.G. Walsh* (MEL); Mt. Raymond, 14 km east of Orbost, 14.x.1945, *N.A. Wakefield 4060* (MEL); Mallacoota Inlet National Park, 7.viii.1970, *A.C. Beauglehole 33639* (MEL); Nooramunga Wildlife Reserve, St. Margaret Island, 8.xii.1978, *A.C. Beauglehole 62340* (MEL); Boggy Creek, 1937, *F. Robbins, A.C. Beauglehole 3762* (MEL); Croajingalong National Park, Betka River, 8.xii.2009, *J.A. Jeanes 2258* (CANB, K, MEL, NSW); Golden Beach, Lake Reeve, 2.xii.2015, *V. Stajsic 7728* (MEL); 17 km north of Orbost on the Bonang Highway, 17.viii.1983, *K.R. Thiele 516* (MEL); Macalister [River], *E.A. Chesterfield 1505* (MEL).

***Distribution*:** From Nadgee Nature Reserve in southeastern New South Wales through near-coastal areas of Gippsland, Victoria to Wilsons Promontory area, with an outlying occurrence in the Macalister River catchment (northwest Gippsland).

***Etymology*:** From the Latin *attenuatus*, meaning narrowed and elongated, in reference to the long, thin phyllodes typical of this subspecies.

***Notes*:** Differentiated from subsp. *genistifolia* which has phyllodes that are generally shorter (14–26(–40) mm), <20 times longer than wide and more spreading. Distinguished from subsp. *platyphylla* which has typically broader phyllodes (>1.5 mm wide) that are generally flattened in cross-section. Its range does not overlap with that of subsp. *platyphylla* or subsp. *genistifolia*. Following the fires of the 2019–2020 summer, much of the habitat of this subspecies has been burnt. Although, as with most wattles, it will most likely regenerate well from soil-stored seed.

***Acacia genistifolia* Link subsp. *platyphylla* A.T.Webb, subsp. nov.**

Acacia prostrata Lodd., G.Lodd. & W.Lodd., *Bot. Cab.* 7:631 (1822) Type: plate in *Bot. Cab.*, 'A native of Van Diemens Island; we raised our plants from seeds in 1818, and they flowered two years afterwards'.

***Type*: AUSTRALIA.** Tasmania. c. 40 km east-northeast of Hobart, 6 km north along Kellevie Rd. from Arthur Highway near Copping, 2 km north-east along Franklins Rd., 42° 45′ S, 147° 49′ E, 27.vii.1983, *J.D. Briggs 962* (holo: MEL249261, iso: CANB, HO).

Phyllodes flattened to rhombic in transverse section, linear to narrow-ovate or narrow-oblong, sometimes subulate or sub-falcate, 1.5–4.5 mm in diameter, 10–27(–50) mm long, diverging from the stem at (33–)45–78°. *Pods* with sparse to moderate covering of short appressed hairs, (34–)40–80(–91) mm long, 2–7(8) mm wide.

***Selected specimens examined (20)*: VICTORIA.** Grampians: Plantation Road between Halls Gap and Roses Gap, 28.v.1963, *T.B. Muir 2856* (MEL); 4 km north of Zumsteins, 28.ii.1988, *S.T.W. Parfett 143* (AD, BRI, MEL). Otways: off Distillery Creek Road, inland from Aireys Inlet, 5.ix.2003, *G.W. Carr 0309-82/1* (MEL); Moonlight Head, 7.ix.1980, *M.G. Corrick 6545* (MEL); Corangamite [Otways] 8 km east-southeast of Carlisle River, 3.x.1985, *S.G. Harris 68* (CANB, HO, MEL, PERTH). Wilsons Promontory Region: Fish Creek Quarry, ix.2006, *B. Teesdale s.n.* (MEL2393634). **TASMANIA.** Furneaux Group: Clarke Island, 1894, *E. Maclaine s.n.* (MEL500416); Flinders Island, Middle Patriarch, southern slope, 6.x.1978, *J.S. Whinray 2488* (CANB, MEL). Central North: near Prossers Forest, 17.xii.1969, *M.G. Corrick 2021* (MEL). East Coast: Orford, above Prosser River, 29.xii.1969, *M.G. Corrick 2095* (MEL). North East: Scamander, Winifred Curtis Reserve, 17.xii.2009, *J. Wood 120* (HO, K, MEL); north of St. Helens, broad ridge south of Swimcat Creek, 24.vii.1981, *A. Moscal 829* (MEL). South East: Lindisfarne, 3.ix.1923, *R.A. Black 253*, (MEL); 1.5 km south of Observatory Hill, 19.ix.1984, *W.F. Pataczek 012* (MEL); Brown Mountain, bottom slopes, 1892, *Rev. J. Bufton 18* (MEL); Eaglehawk Neck, 17.xii.1952, *J.H. Willis s.n.* (MEL500421); Pittwater Bluff, 8.ix.1984, *A. Moscal 8410* (MEL); Fortescue Bay, Cape Hauy Track, 18.xii.1980, *A. Brown 75* (AD, MEL); Remarkable

cave near Port Arthur, 20.ix.1981, *A. Brown 319* (HO, MEL); Southport Island, xii.1858, *F. Mueller s.n.* (MEL500423).

***Distribution*:** In Victoria, recorded from the Grampians, Otway Range and Wilsons Promontory region (Foster and Fish Creek). It is of predominantly Tasmanian distribution, particularly the southeast around Hobart and the Tasman Peninsula, along the eastern and northeastern coasts and including the islands of the Furneaux Group.

***Etymology*:** From the Greek *platy-* (flat, broad) and *phyll-* (pertaining to leaves), in reference to the flattened phyllodes typical of this subspecies.

***Notes*:** In general, Tasmanian plants have relatively shorter phyllodes than do those from Victoria. This may be due to a longer period of genetic isolation from the 'typical' subspecies in the Tasmanian population, while some degree of genetic 'leakage' between subsp. *genistifolia* and subsp. *platyphylla* may be ongoing in Victorian populations. This subspecies is differentiated from other subspecies which have generally narrower phyllodes (<1.5 mm wide) that are typically subterete to terete. It is the only subspecies that occurs in Tasmania. It is not uncommon and is well reserved in Tasmania but can be considered rare in Victoria.

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Muelleria

39: 127–134

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ROYAL BOTANIC GARDENS VICTORIA

Two new endemic species of *Craspedia* (Asteraceae: Gnaphalieae) from Victoria

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Introduction

Two informally named species were included in the account of *Craspedia* G.Forst. in volume 4 of the *Flora of Victoria* (Everett 1999) and its on-line derivative *VicFlora* (https://vicflora.rbg.vic.gov.au/) including brief descriptions and keys to identification. At the time of publication of the *Flora,* the distribution and ecology of the species were poorly known and some morphological features only partially understood. Some specimens of the two species at MEL, returned after being on extended loan to NSW, had been annotated by Joy Everett as *Craspedia sylvestris* and *C. basaltica*, neither having been formally published. The opportunity is taken here to more fully circumscribe these distinctive species and their habitats and formalise these names.

Craspedia sylvestris* J.Everett ex N.G.Walsh *sp. nov.

Craspedia sp. 1 *sensu* J. Everett in N.G. Walsh & T.J. Entwisle (eds), *Flora of Victoria* 4: 763 (1999), Walsh, N.G. & Stajsic, V. (2007), *A Census of the Vascular Plants of Victoria* edn. 8: 55, 176; *Craspedia* sp. Subalpine (N.G.Walsh 5149) Vic. Herbarium, Australian Plant Name Index (https://biodiversity.org.au/nsl/services/APNI).

***Type:* VICTORIA**. Mount Buller. Summit Nature Trail between Burnt Hut Reservoir and Boggy Creek ski run, *N. Karunajeewa 1258*, 10.i.2016 (holotype: MEL 2393129; isotypes BRI, CANB, CHR, NSW, PAL, S).

Rosetted perennial herb, shortly rhizomatous; flowering scapes often red-tinged, sometimes sparsely cottony below inflorescence, 50–70 cm high, 1 or 2 per rosette, but rosettes sometimes crowded

Abstract

Two species of *Craspedia*, *C. basaltica* and *C. sylvestris*, confined to grasslands of western Victoria and subalpine woodlands and forests of eastern Victoria respectively are described as new. The names replace informal names *Craspedia* sp. 1 and *C.* sp. 2 *sensu* Everett 1999 as described in volume 4 of the *Flora of Victoria* (hard copy) and the online *VicFlora*. A key is provided to the Victorian species of *Craspedia*. With the description of the two new species, 13 species of *Craspedia* are now formally recognised from Victoria.

Keywords: Victoria, endemic flora, montane forest, volcanic plain grassland

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Figure 1. *Craspedia sylvestris* Holotype (MEL 2393129).

and inflorescences then appearing more numerous; roots, thick, spreading, woolly. Basal leaves ascending or widely spreading, rather flaccid, elliptic to obovate, the lamina 60–100 mm long, 20–40 mm wide, green, tapered to a rather distinct, usually deep reddish or purplish 'petiole' 30–70 mm long; surfaces slightly rough with sparse multiseptate hairs and often with sparse to moderately dense cottony hairs on the margins; secondary veins (1 or 2 either side of the midvein) usually apparent, but much finer than midvein, curving from lamina base to apex. Stem bracts c. 10–15, ovate, those from about halfway up scape to the inflorescence with broad amplexicaul bases, margins often undulate. Inflorescence orange, hemispherical to globular 2–3 cm diam., with 40–70 capitula. Capitula each with 8–11 florets; bract subtending individual capitula ovate to broadly ovate, 3.5-4.5 mm long, 2-4 mm wide; margin membranous, hyaline to brown-translucent, to c. 1 mm wide, entirely surrounding the stereome, occasionally virtually absent and then almost the entire bract opaque, green or flushed purplish; stereome ovate to broadly ovate, minutely glandular, base woolly; bracts subtending individual florets ovate to obovate, 5–6 mm long, hyaline. Cypselas 1–2 mm long, 0.2–1.5 mm wide; pappus 3–5.5 mm long. Flowers summer (Figures 1, 2).

Selected specimens examined: **VICTORIA.** Mt Hotham, Alpine Rd c. 2 km E of Dargo Rd, *P.G. Neish 581*, 7.iii.1998 (MEL, NSW); Howqua River area, road to The Bluff, *A.C. Cochrane 857*, 28.i.2000 (MEL); Mt Buffalo NP, track to Mollison Galleries, *N.G. Walsh 5149*, 28.i.2000 (MEL); Mt Buller, Boggy Creek area, *C.W. Huggins*, 31.i.1989 (MEL); The Bluff, *N.G. Walsh 949*, 22.i.1981 (MEL); Mt Buller, ca 1 km from Alpine Village, *J. Russell 76-91*, 23.i.1974 (MEL); Omeo Plain, *M.G. Corrick 10434*, 22.i.1989 (MEL); Crosscut Saw between Mt Howitt and Mt Speculation, *N.G. Walsh 2528*, 7.i.1981 (MEL); Bogong National Park, 36 km generally S of Harrietville, *R.M. King 9768* (MEL, US); Southern slopes of Mt Stirling, near Howqua Gap, *M.G. Corrick 7985*, 31.i.1982 (MEL); King Spur Tk, ca 38 km N of Dargo, *R.A. Kilgour 199*, 1.ii.1982 (MEL)

Distribution and habitat: Endemic in Victoria. Principally in montane to subalpine (between ca 1300 and 1700 m a.s.l.) woodland and forest of the Mt Matlock, Snowy Range, The Bluff, Mt Buller, Mt Buffalo, Mt Stirling and Mt St Bernard areas where *Eucalyptus delegatensis* R.T.Baker and *E. pauciflora* Sieber ex Spreng. are the common canopy dominants. Also in rather dense shrublands dominated by e.g. *Podocarpus lawrencei* Hook.f., *Prostanthera cuneata* Benth. It rarely, if ever occurs in treeless alpine grassland/open heaths where e.g. *Craspedia aurantia* J.Everett & Joy Thomps., *C. crocata* J.Everett & Joy Thomps., *C. gracilis* Hook.f., *C. adenophora* K.L.McDougall & N.G.Walsh are frequent (Figure 3).

Notes: The ovate to broadly ovate, narrowly-margined bracts of the individual capitula are distinctive and contrast to those of other species of subalpine to alpine *Craspedia* of similar habit (in particular *C. aurantia*, *C. crocata* which have broad hyaline margins, often widely dilated in the proximal half to the extent that the bract is somewhat 3-lobed. From *C. aurantia* it is further distinguished by the long 'petiolate' leaves and from *C. crocata* (which is generally a species of higher mountains in Victoria) by the overall more robust habit, broader leaves and bracts and proportionately larger inflorescences. Some 'shade' forms of *C. variabilis* J.Everett & Doust approach *C. sylvestris* in habit, but

Figure 2. *Craspedia sylvestris* Capitular bract (from MEL 2045414).

the leaves are rarely wider than 20 mm, the florets yellow rather than orange, and the capitular bract with membranous margins wider than the stereome. *Craspedia variabilis* is not known to occur at elevations above *ca*. 1000 m, considerably below the lowest altitudinal limit of *C. sylvestris*.

The species is locally common, but currently not recorded from a number of high-montane forest areas that have similar habitats to those at known sites. It could be anticipated to occur in such areas (e.g. forests surrounding the Bogong High Plains, the Nunniong Plateau and the Cobberas Range). It is reasonably represented in national parks (Alpine NP, Mt Buffalo NP). However, like many alpine/subalpine herbs, it is very susceptible to a projected drier and hotter climate as modelled by the CSIRO (2020) https://www.climatechangeinaustralia.gov.au/en/. An IUCN (2020) assessment produces a risk code of Vulnerable (VU (A3c)).

The manuscript name *Craspedia* sp. 'Loveridge' appears on some labels of specimens of this species collected in Victoria at NSW (e.g. *J.A. Jeanes* 2319). The reason for this is unknown and the author of the labels is not recorded. The same informal name has been used for a New Zealand plant (Druce 1992) collected from the 'Loveridge Basin' which is no longer recognised as distinct (de Lange et al. 1999). It is considered most unlikely that this manuscript name for a New Zealand species is the same taxon as *C. sylvestris*.

Etymology: The name from the Latin meaning 'of forests' was suggested by Everett. While not always appropriate (some plants occur in *Eucalyptus pauciflora* subalpine woodlands), the name is retained to avoid confusion on specimens so annotated by her.

Craspedia basaltica J.Everett ex N.G.Walsh ***sp. nov.***

Craspedia sp. 2 *sensu* J. Everett in N.G. Walsh & T.J. Entwisle (eds), *Flora of Victoria* 4: 763 (1999); Walsh, N.G. & Stajsic, V. (2007), *A Census of the Vascular Plants of Victoria* Edn. 8:55, 176; *Craspedia* sp. Derrinallum (*N.G.Walsh 5591*) Vic. Herbarium, Australian Plant Name Index https://biodiversity.org.au/nsl/services/APNI.

Type: **VICTORIA**. Nerrin Nerrin-Woorndoo Rd, 4 km WSW of Mt Hamilton, *S.J. Forbes 1433*, 3.ix.1983 (holotype: MEL 666789; isotypes: AD, NSW).

Rosetted perennial herb, shortly rhizomatous; flowering scapes 1–4 per rosette, to 20(–30) cm high;

Figure 3. Distribution of *Craspedia sylvestris* (triangles) and *C. basaltica* (closed circles), based on herbarium collections at MEL.

roots thick, spreading, woolly, commonly emerging at successive levels from rootstock. Rosette leaves usually rather crowded, ascending-spreading, lamina narrow-elliptic or narrowly obovate, 20–30(–60) mm long, 2–6(–10) mm wide, green, with scattered multiseptate eglandular hairs to c. 0.5 mm long, usually some sessile or subsessile glands present at least abaxially when young, base attenuated and petiole-like, usually reddish, about as long as or longer than lamina; leaf remnants usually retained as a fibrous tunic surrounding the current season's rosette for several seasons. Stem bracts c. 8–12, narrowly ovate to lanceolate, sessile (sometimes amplexicaul) from about the third bract from the base to the inflorescence, margins plane. Inflorescence pale yellow, c. spherical, 15–25(–40) mm diam., with 20–40 capitula on peduncles c. 2 mm long; scape straw-coloured to reddish, with some spreading multiseptate hairs in the lower part, but with mainly loose to moderately dense cobwebbed heads beneath the inflorescence. Individual capitula mostly with 5 or 6 (rarely to 8) florets; bract subtending individual capitula broadly ovate, 4.5–6 mm long, 2.5–3.5 mm wide, margins membranous, colourless to brown, stereome very small, much narrower than membranous margins and usually only c. half as long as the entire bract, finely woolly at base. Cypselas 1.5–2 mm long, 0.6–1 mm wide, white-sericeous; pappus 3–5 mm long. Flowers Aug.–Oct. (Figures 4, 5).

Selected specimens examined: **VICTORIA.** Chatsworth Rd, 8 km W of Derrinallum, *K.L. McDougall s.n.*, 11.x.1990 (MEL *p.p.*, with *C. variabilis*); Bannockburn Rail Reserve, c. 2.5 km NW of rail station, *N.G. Walsh 5591 & N. Williams*, 18.ix.2002 (MEL); Shelford-Mt Mercer Rd, c. 3 km NNW from Rokewood-Shelford Rd, *N.G. Walsh 5594 & N. Williams*, 18.ix.2002 (MEL); Shelford-Mt Mercer Rd, c. 5 km N of Shelford-Rokewood Rd, *J.A. Jeanes 1224, M.J. Hirst & N. Polidarpowski*, 14.x.2005 (MEL); Laverton, near Fitzgerald Rd, *collector unknown*, ix.2001 (MEL); Rockbank, Clarke Rd grassland, *V. Stajsic 7311 & J.A. Jeanes*, 7.xi.2012 (MEL); ca 8 km SW of Werribee, on railway reserve, *R.J. Adair 1760*, 29.ix.1982 MEL); Woorndoo-Streatham Rd, 1.5 km NE of Pagels Lane, *N.G. Walsh 8853 & A. Messina*, 15.xi.2018 (MEL); Little River, *J.P. Fullagar s.n.*, s.d. (MEL); 1 km W of Poorneet Rly Siding, 0.5 km SE of Cressy PO, *A.C. Beauglehole 58416* (MEL); Geelong-Ballarat rail line, c. 6 km S of Meredith, *S.J. Platt 122*, 30.x.1984 (MEL); Rail crossing of the Camperdown-Lismore Rd, 3 km SW of Lismore PO, *G.J. Hirth*, 18.ix.1977 (MEL). 3 miles [5 km] W of Kaniva, *R. Melville 877*, 15.ix.1952 (K, MEL); Ararat, *C. Green 66*, s.d. (MEL).

Distribution and habitat: Apparently endemic in Victoria. Rare, now apparently restricted to drier grasslands of the Volcanic Plain west of Melbourne (e.g. Deer Park, Bannockburn, Shelford, Little River, Derrinallum areas), but apparently formerly with outlying occurrences in the Wimmera near Ararat, Kaniva and Rupanyup, where likely associated with heavier (cracking clay) soils of the Wimmera, but not recorded from these latter sites for many decades and now possibly extinct from these localities. The Kaniva locality is close to the South Australian border, and similar soils occur in that state contiguous with those of the Victorian Wimmera (Govt of South Australia, 2016), so *C. basaltica* could be anticipated to occur (or have occurred) there as well, but there are no specimens at MEL (Figure 3).

Most likely confused with small forms of *C. variabilis* but differing in the relatively narrower leaves, the generally fewer-flowered capitula (those of *C. variabilis* 7–12-flowered), the smaller inflorescences, and the capitulum-subtending bracts with a very narrow stereome, significantly narrower than the membranous margins (stereome as wide or wider than the margins in *C. variabilis*). While *C. variabilis* is, true to its epithet, variable both in morphology and habitat, *C. basaltica* is constant in both habit and its (usually clay-based) grassland habitat.

Like many forbs of grasslands of the volcanic plain, *C. basaltica* has become exceedingly rare largely as a result of land clearance. In the western part of its range, land clearing occurred for agriculture, but more recently in sites nearer Melbourne, clearing has occurred for housing and industrial development. It is not known from any gazetted reserve and persists on relatively few road and rail reserves, many of which are threatened through weed invasion or inadvertent destruction through ploughing or roadworks. An IUCN (2020) assessment produces a risk code of Endangered (EN (B2ab)).

Etymology: The epithet, undoubtedly relating to the species' restriction to basaltic clay soils (at least apparently nowadays) was suggested by Everett. The name is appropriate and retained to avoid confusion on specimens so annotated by her.

cm
0 1 2 3 4 5 6 7 8 9 10
copyright reserved
MEL 666789
NATIONAL HERBARIUM OF VICTORIA (MEL)
Craspedia
Loc. VICTORIA - Herrin Herrin - Macarthur road, 4 km. WSW of Mt. Hamilton, near Vogel's Lane.
Lat. 37°48'S Long. 142°50'30" Qad 339
Coll. S.J. Forbes no. 1493
3.10.1991.
Note: Grassland/low open herbland dominated by Themeda australis and Leptorhynchos squamatus. Heavy black cracking clays in depressions and white clays, & basalt on rises/ridges.
Mountant herb
Exsl.: MEL, AD.
NATIONAL HERBARIUM OF VICTORIA (MEL), AUSTRALIA

Figure 4. *Craspedia basaltica* Holotype (MEL 666789).

Figure 5. *Craspedia basaltica* Capitular bract (from MEL 665686).

Acknowledgements

I am grateful to my colleagues at MEL, for preparation of figures: Angharad Johnson photographed Figures 1 and 4, Andre Messina assisted with Figures 2 and 5, and Alison Vaughan prepared Figure 3. Naturally, this work draws heavily on Joy Everett's (1999) treatment for the *Flora of Victoria* to which I am indebted.

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Key to Victorian species of *Craspedia*

1 Short-lived plant with a single tap-root; north-west Victoria only ..... ***C. haplorrhiza***

1: Perennial plant with many secondary roots; absent from, or very rare in north-west 2

2 Flowers white ..... ***C. alba***

2: Flowers yellow or orange 3

3 At least the abaxial leaf surfaces with more or less covered by appressed copious cottony or woolly hairs 4

3: Leaf surfaces glabrous or with septate or glandular hairs but not covered by appressed hairs, but hairs sometimes forming a marginal fringe 7

4 Leaves distinctly discolorous with abaxial surface more densely hairy than the adaxial, sticky-glandular, often aromatic when crushed with a scent reminiscent of orange peel ..... ***C. adenophora***

4: Leaves more or less concolorous, not sticky 5

5 Robust plants with very densely white-woolly leaves (at least on the abaxial surfaces); inflorescences (25–)30–40 mm in diameter; alpine ..... ***C. maxgrayi***

5: Small to robust plants with sparsely to densely silvery grey-woolly leaf surfaces; inflorescences 12–30 mm in diameter 6

6 Rosette leaves sparsely to densely hairy, with two somewhat indistinct arching secondary veins; lowlands ..... ***C. canens***

6: Rosette leaves moderately to densely hairy, with two or four very distinct secondary veins running more or less parallel to the central vein; subalpine to alpine ..... ***C. gracilis***

7 Plants mostly above 50 cm high and up to 1 m; rosette leaves narrowly oblanceolate to oblong, often greater than 15 cm long, usually glabrous or glabrescent; mostly lowland swamps and drainage lines ..... ***C. paludicola***

7: Plants mostly 50 cm high or lower; rosette leaves obovate to oblanceolate (or narrower in rare C. basaltica), mostly conspicuously hairy, or if glabrous an alpine species 8

8 Rosette leaves with leaf bases broadly attenuate, not distinctly petiolate; subalpine to alpine 9

8: Rosette leaves with leaf bases long-attenuate, usually distinctly petiolate; lowland to alpine 10

9 Rosette leaves subglabrous except for a fringe of hairs around the margins; moist to wet habitats ..... ***C. lamicola***

9: Surfaces of rosette leaves with robust septate hairs; drier habitats ..... ***C. aurantia***

10 Flowers always yellow; lowland 11

10: Flowers usually orange, more rarely yellow; montane or subalpine 12

11 Leaves 10 mm wide or less, blade less than half the total leaf length, base conspicuously red-tinged; virtually confined to grasslands of the volcanic plain west of Melbourne ..... ***C. basaltica***

11: Widest leaves usually more than 12 (rarely c. 8) mm wide, blade more than half the total length, base green or white; widespread, rare on the volcanic plain ..... ***C. variabilis***

12 Basal leaves linear-spathulate to spathulate, the widest to 12 mm wide, mostly long-attenuate at base; capitula 1–2 cm diameter; typically a species of moist grassland in alpine areas ..... ***C. crocata***

12: Basal leaves broadly spathulate, the widest 20–40 mm wide, very long-attenuate at base; capitula 2–3 cm diameter; mostly in grassy understorey of montane woodlands and forests ..... ***C. sylvestris***

Muelleria

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ROYAL BOTANIC GARDENS VICTORIA

Corrections to '*Agrostis semibarbata*: an old name for *Lachnagrostis punicea* (Poaceae)' (Brown 2019) *Muelleria* 38, pp. 17-25

A.J. Brown

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Two inadvertent errors were noted by the author after the online publication of this paper.

Firstly, on p. 18, "*D. Billardieri b*" should have been printed as "*D. Billardieri ß*".

Secondly, the sixth sentence under 'Identifying the original collection' on p. 20, should be replaced with 'Two sheets at K are marked with either "V.D.L.10" (K000913405–K000913406: *Dichelachne crinita*) or "V.D.L.12" (K000838424: *Deyeuxia lawrencei*), and a further sheet at LE is marked "V.D.L.7 Hooker" (LE TRIN–1584.06: *Lachnagrostis aemula*), suggesting that a series of duplicates were prepared by Hooker for Trinius.'

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